REPORT

OF THE

Proceedings of the Fifth Entomological Meeting

Held at Pusa on the 5th to 10th February 1923

Edited by

T. BAINBRIGGE FLETCHER, R.N., F.L.S., F.E.S., F.Z.S.

Imperial Entomologist

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PREFACE.

THE Report attached hereto contains a record of the Proceedings of the Fifth Entomological Meeting, which was held at Pusa from 5th to 10th February 1923.

Several papers, other than the sixty-one here included, were read at the Meeting, but, as they have not been submitted for publication, have been excluded from the Report.

In compliance with Government orders to condense the Report as far as possible, I have freely used the editorial blue-pencil to excise all non-essential illustrations and passages from the papers submitted, whilst the discussions have only been given in abstract.

It may save correspondence to state here, once again, that no Report of the First Entomological Meeting, held in 1915, was ever issued. Reports of the Second and Third Meetings are still available. That of the Fourth, printed in a limited edition, is already out of print.

T. BAINBRIGGE FLETCHER,
Imperial Entomologist.

PUSA,
13th April 1923.

List of those who attended the Fifth Entomological Meeting held at Pusa on 5th to 10th February 1923.

MEMBERS.

1. C. F. C. BEESON, M.A., D.Sc., F.E.S., Forest Entomologist, Dehra Dun.
2. S. C. J. BENNETT, Second Bacteriologist, Muktesar.
3. B. B. Bose, B.Sc., Assistant to the Imperial Entomologist, Pusa.
4. Rai Sahib P. N. DAS, G.B.V.C., Assistant Director, Civil Veterinary Department, Bihar and Orissa.
5. G. R. DUTT, B.A., Personal Assistant to the Imperial Entomologist, Pusa. (*Joint Secretary*).
6. H. L. DUTT, M.S.A., Assistant Professor of Entomology, Bihar and Orissa.
7. J. T. EDWARDS, M.R.C.V.S., Director and First Bacteriologist, Muktesar.
8. T. BAINBRIGGE FLETCHER, R.N., F.L.S., F.E.S., F.Z.S., Imperial Entomologist, Pusa. (*Chairman*).
9. RAM GOPAL, M.A., M.R.A.C., F.R.H.S., P.A.S.I., N.D.D., Director of Agriculture, Kashmir State.
10. ABDUL HAQ, Insectary Fieldman, Pusa.
11. G. R. HILSON, B.Sc., Cotton Specialist, Madras.
12. Major R. W. G. HINGSTON, I.M.S., M.C., M.B., F.R.G.S., F.Z.S., Fyzabad.
13. M. AFZAL HUSAIN, M.A., M.Sc., Government Entomologist, Punjab.
14. C. M. INGLIS, M.B.O.U., F.E.S., F.Z.S., Laheria Sarai.
15. P. V. ISAAC, M.Sc., F.E.S., Second Entomologist (Dipterist), Pusa.
16. M. O. T. IYENGAR, B.A., F.Z.S., Entomologist, Sanitary Department, Bengal.
17. N. K. JARDINE, F.E.S., Government Entomologist, Ceylon.
18. K. KUNHI KANNAN, M.A., PH.D., F.E.S., Senior Assistant Entomologist, Mysore.
19. M. B. MENON, G.B.V.C., Veterinary Inspector, Muktesar.
20. S. MILLIGAN, M.A., B.Sc., Agricultural Adviser to the Government of India and Director, Agricultural Research Institute, Pusa.
21. Rai Bahadur C. S. MISRA, B.A., First Assistant to the Imperial Entomologist, Pusa.

22. G. D. Misra, Entomological Assistant, United Provinces.
23. Ahmad Mujtaba, Assistant to the Imperial Entomologist, Pusa.
24. D. Nowroji, B.A., Assistant to the Imperial Entomologist, Pusa.
25. G. D. Ojha, Fieldman, Entomological Section, Pusa.
26. R. L. Pendleton, B.Sc., Ph.D., Director of Agriculture, Gwalior.
27. V. R. Phadke, G.B.V.C., Assistant Professor, Veterinary College, Bombay.
28. R. V. Pillai, G.B.V.C., Deputy Superintendent, Civil Veterinary Department, Central Provinces.
29. Rao Sahib Y. Ramachandra Rao, M.A., F.E.S., Acting Government Entomologist, Madras.
30. P. B. Richards, A.R.C.S., F.E.S., Government Entomologist, United Provinces. (*Joint Secretary*).
31. Ram Saran, Fieldman, Entomological Section, Pusa.
32. S. K. Sen, B.Sc., Assistant to the Imperial Entomologist, Pusa.
33. Mohammad Shaffi, Fieldman, Entomological Section, Pusa.
34. H. N. Sharma, B.A., Assistant to the Imperial Entomologist, Pusa.
35. Dwarka Prasad Singh, Fieldman, Entomological Section, Pusa.
36. Harchand Singh, L.Ag., Agricultural Officer, Patiala.
37. Ram Narain Singh, Entomological Assistant, United Provinces.
38. Major J. A. Sinton, V.C., O.B.E., I.M.S., Officer in Charge, Quinine and Malaria Inquiry, Kasauli.
39. S. Sultan Ahmad, G.B.V.C., Deputy Superintendent, Civil Veterinary Department, Bengal.
40. T. M. Timoney, M.R.C.V.S., Third Bacteriologist, Muktesar.
41. Torabaz Khan, G.B.V.C., Veterinary Inspector, Muktesar.

The following, who did not attend the meeting, took part by the contribution of papers.

42. T. V. Ramakrishna Ayyar, B.A., F.E.S., F.Z.S., Assistant Entomologist, Coimbatore.
43. E. Ballard, B.A., F.E.S., Government Entomologist, Madras.
44. Dina Nath, L.Ag., Entomological Assistant, Punjab.
45. Major F. C. Fraser, I.M.S., Civil Surgeon, Ootacamund.
46. C. C. Ghosh, B.A., F.E.S., Assistant Entomologist, Burma.
47. E. Ernest Green, F.E.S., Camberley, England.
48. Harnam Das Bhasine, M.Sc., Officiating Assistant Professor of Entomology, Punjab.
49. Hira Lal, B.Sc., Lahore.
50. T. V. Subramanyam, B.A., Entomological Assistant, Madras.
51. P. Susainathan, F.E.S., Entomological Assistant, Madras.

52. UMRAO BAHADUR MATHUR, L.AG., Entomological Assistant, Punjab.
53. B. P. UVAROV, F.E.S., British Museum, London.
54. R. SENIOR WHITE, F.E.S., Malariologist, Suduganga Estate, Matale, Ceylon.

VISITORS.

55. Dr. D. F. MICHAEL, I.M.D., Medical Officer, Pusa.
56. Dr. C. GIBBON, Medical Officer, B. and N.-W. Ry., Samastipur.
57. Mrs. BAINBRIGGE FLETCHER.
58. Mrs. BEESON.

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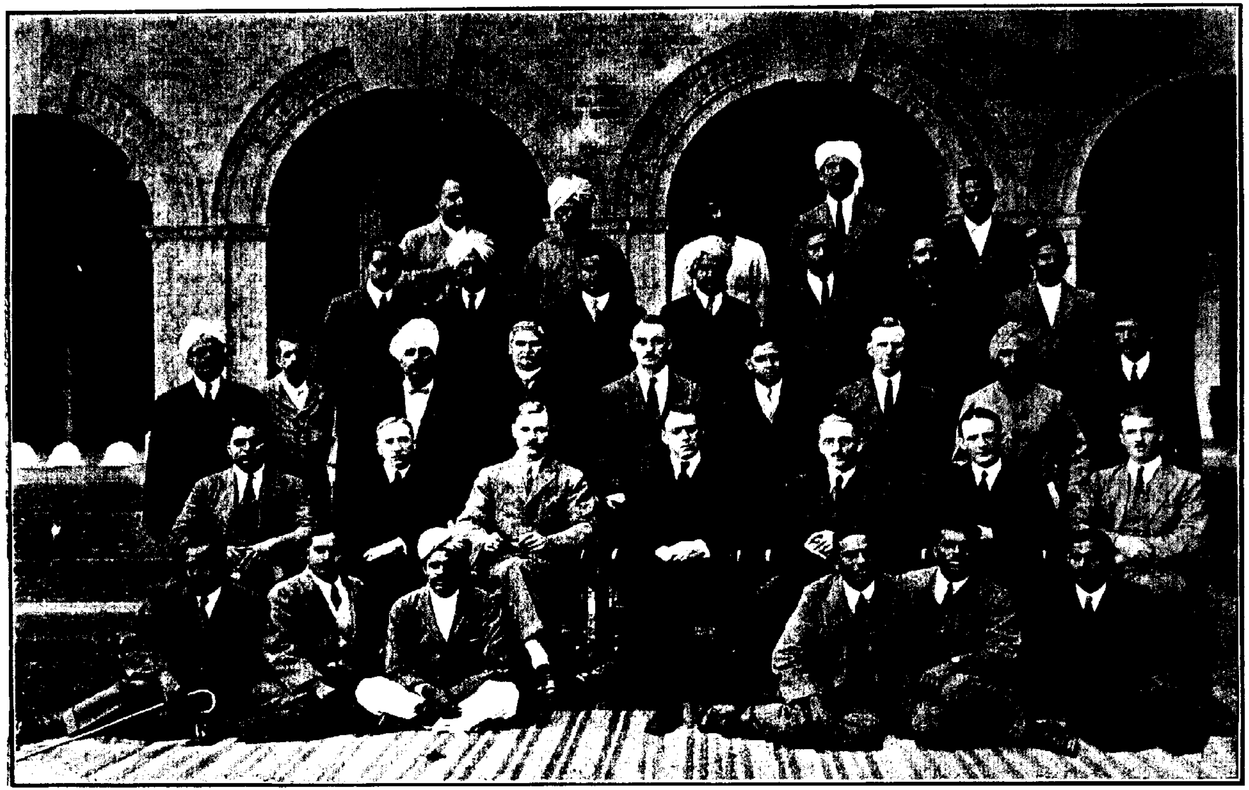


Fifth Row—(Standing) Messrs. Mukerjee, Ojha, Bashir, Torabaz Khan, D. P. Singh.
Fourth Row—(Standing) Messrs. Iyengar, R. N. Singh, Sultan Ahmad, G. D. Misra, Sharma, Mujtaba, Shaffi.
Third Row—(Standing) Rao Sahib Rama Chandra Rao, Messrs. Naoroji, G. R. Dutt, Rai Bahadur C. S. Misra, Messrs. Bennett, Isaac, Timony, Harchand Singh, Sen.
Second Row—(Seated) Mr. Husain, Major Hingston, Dr. Beeson, Messrs. Bainbrigge Fletcher, Richards, Edwards, Major Sinton.
First Row—(Seated) Rai Sahib P. N. Das, Messrs. Bose, Ram Saran, Pillai, Menon, Phadke.

PROCEEDINGS

OF THE

Fifth Entomological Meeting.

The Fifth Entomological Meeting was held at Pusa from the 5th to the 10th of February 1923. The Proceedings were opened by Mr. S. Milligan, M.A., B.Sc., Agricultural Adviser to the Government of India.

Introductory address by the Agricultural Adviser.

Mr. Fletcher and Gentlemen:—In the first place I desire, on behalf of my colleagues and myself, to offer the visitors a very hearty welcome to Pusa. This is the fifth of the series of Entomological Meetings which have alternated with those of the Board of Agriculture since the year 1915 and which have attracted much attention both in India and abroad. I am glad that, in spite of the general financial situation, there has been no necessity to break the continuity of the series, although many have been prevented from attending, and the Meeting is not quite so large as we had at one time hoped. We regret the absence of many of our prominent workers and extend a special welcome to those who, in spite of all difficulties, are present here to-day. The Indian States have, I am glad to say, seen their way to continue their support and are again strongly represented. We are grateful to the Government of Ceylon for again sending a representative this time in the person of Mr. Jardine. The Medical and Forest Departments are old friends and strong supporters and we all are aware of the mutual benefit which we have derived through collaboration. It is also a matter for congratulation that we have present to-day the Director and two of the staff accompanied by six of the post-graduate students from Muktesar, an eloquent tribute to the importance which that Institute attaches to Entomology.

Gentlemen, your programme of work is a very comprehensive one and includes much of immediate practical importance. From the agricultural point of view there are no groups of pests of more importance than those attacking cotton. The cotton plant, or at least the "busi-

ness end " of it, is by no means robust and falls an easy prey to insect attack. Unless something can be done, we are threatened with a permanent rise in the cost of cotton goods—a very serious matter to tropical and sub-tropical countries.

The paper on the American cotton boll weevil which is to be given by your Chairman is specially opportune as the subject is up for discussion at the next meeting of the Indian Central Cotton Committee. Your proceedings under this subject will, I assure you, be very closely followed by the members of that Committee and any practical suggestions towards protecting India from this terrible scourge will be eagerly welcomed.

But the agricultural side forms only a section of your programme which covers so wide a field as forest, medical, veterinary and household entomology, while the industrial side is represented in " lac " and sericulture. With such a programme your Chairman will, I know, want to get down to business with the least possible delay. I wish you a successful Meeting.

Mr. Milligan was followed by the Chairman, Mr. T. Bainbrigge Fletcher, Imperial Entomologist, who first thanked Mr. Milligan on behalf of the Meeting for opening the Conference, and then addressed the Meeting.

Chairman's Opening Address.

Another two years have gone by and we are again met together to-day to commence the Fifth of our biennial Entomological Meetings of which the First was held here in 1915, when we Entomologists were the inaugurators of these Sectional Conferences. This year, as was the case eight years ago, the Entomological Meeting is the only one to be held, and that we are the only survivors on this occasion seems to afford proof, if such be needed, that our biennial Meetings meet a real need on the part of those who attend them, whilst our published Proceedings form a solid record of current progress thus rendered available to all other workers on our subject both in India and abroad. At this Meeting we are pleased to see many of those who have contributed to the success of our former Meetings and also many new faces. The Forest Department has again sent us their Forest Entomologist, the Medical Department has deputed Major Sinton, the Entomologist to the Sanitary Commissioner in Bengal is present here, the Ceylon Government has deputed Mr. Jardine, the Agricultural and Veterinary Departments in India are represented by delegates from Muktesar, Madras, the Punjab, the United Provinces, Bihar, Mysore, Kashmir, and Gwalior, whilst the amateur

entomologists, whom we are always glad to see and to help as far as possible, are also represented by Major Hingston and Mr. Inglis. On behalf of the Pusa Entomological Staff I extend a very hearty welcome to all our visitors.

The newly-founded Calcutta School of Tropical Medicine was to have been represented by their Professor or Entomology, but unfortunately he has been unable to come at the last moment, and Dr. Cameron, Systematic Entomologist at the Forest Research Institute, who had also intended to come, has also been prevented at the last moment by illness.

Owing to financial stringency, depletion of staff, and other causes, we miss the presence of representatives from the Zoological Survey, the Indian Tea Association, the North-West Frontier Province, Bombay, the Central Provinces, Bengal, Assam and Burma. We miss not only their presence but their aid in assisting us in the various matters with which we have to deal, and we trust that they will all be able to attend our future Meetings.

At our last Meeting we had occasion to congratulate Rao Sahib Ramachandra Rao as being the recipient of the first honour bestowed by Government for purely entomological work, and on this occasion we have to congratulate Rai Bahadur Chandra Sekhar Misra on the grant of his title for a similar reason. At our Third Meeting, four years ago, Mr. Mackenna told us that " Science is .... like virtue its own exceeding great reward " and it is undoubtedly true that our names will be regarded by our successors in exact proportion to the quality of the work which we leave behind us, but at the same time it is fitting that good work should receive present recognition.

The last two years have been a time of steady progress without any very striking facts to chronicle. The progress made in the study of crop-pests has already been recorded in my Annual Reports of the Pusa Institute and of the Board of Scientific Advice. Regarding Forest Entomology Dr. Beeson will doubtless have something to tell us later on. In Medical Entomology the problem of the transmission of *kala azar* still occupies attention and the Medical Research Fund has employed Captain Barraud to make systematic collections of Culicidæ throughout India. In Veterinary Entomology, the investigation of the transmission of surra was considered at a Meeting of the Surra Committee at Simla in June 1921 when the note read at our last Meeting was taken as a basis for discussion, and the Committee recommended to Government that the question should be investigated by a small body composed of a veterinary pathologist, a protozoologist and a dipterist. So far, however, nothing has come of this proposal. Besides the temporary employment

of Captain Barraud to collect Culicidæ, two new entomological appointments have been filled during the last two years, those of Government Entomologist in the United Provinces and of Professor of Medical Entomology in the Calcutta School of Tropical Medicine. As against these we regret the loss to India, though happily not to Entomology, of Mr. E. Brunetti, of Major Patton, who is now Lecturer in Medical Entomology at Edinburgh, and of Mr. Ballard, who has accepted an entomological post at Bristol. We have also to face the loss in Bihar and Orissa, caused by the abolition, from the end of the current financial year, of the entomological staff of the Agricultural Department.

Besides these, the two years which have elapsed since our last Meeting have unfortunately taken a heavy toll from the small body of workers on Indian Entomology.

Purushottam Govindbhai Patel, who took part here two years ago by a paper on *Culicoides*, was sent on deputation to the Punjab to work under the Camel Specialist on Biting Flies in connection with Camel Surra, and died at his home in Baroda on 13th September 1922. He was one of the earliest members of the staff of the Entomologist to the Government of India, having been entered as a Clerk on 16th February 1904 and promoted to First Fieldman on 12th December of the same year. In September 1906 he was promoted to the post of Fly Assistant, and was employed principally on work in connection with the study of Biting Flies. He was a good field worker but has unfortunately left little on record regarding his observations.

Nagendra Nath Bagchi died in Calcutta on 22nd December 1922. He joined the Artist Staff of this Institute on 15th May 1907 and during his service here had been employed for the most part on entomological drawing work, the illustrations to our entomological publications contributing in no small measure to their success. He came of an artistic family, his father's name appearing on several of the plates illustrating Fayrer's great work on the Poisonous Snakes of India.

Besides these two men who were amongst us so recently, there is a heavy obituary-list amongst those entomologists who have worked especially on Indian Insects.

Robert Charles Wroughton died on 15th May 1921. He was a son of Major-General R. C. Wroughton and was born at Nusserabad on 15th August 1849. Appointed to the Indian Forest Service on 10th December 1871, as Assistant Conservator of Forests in Bombay, he eventually became Inspector-General of Forests, retiring in 1904. During his residence in India he paid a good deal of attention to the ants, forwarding specimens to A. Forel, who named and described them. He published a paper on " Our [Indian] Ants " in the Bombay Journal 1891-92.

Dr. George B. Longstaff died on 7th May 1921, in his 73rd year. He visited India and Ceylon and the results of his journeys are given in his "Butterfly Collecting in many Lands."

Albert Fauvel died in the early part of 1921. He wrote chiefly on Staphylinidæ and described many species from India.

George Alexander James Rothney died on 31st January 1922 in his 73rd year. He came out to Calcutta, in the service of Messrs. C. W. Scott & Co., in 1872 and made a rich collection of Hymenoptera chiefly at Barrackpur, but also in Calcutta, Masuri, Allahabad and the North-West Frontier Province, this collection, which is especially rich in types, being now in the Hope Department of the Oxford Museum. He published Notes on Indian Ants in the Transactions of the Entomological Society, 1889 and 1895, and a very interesting paper on the Aculeate Hymenoptera of Barrackpur in the Transactions of the Entomological Society, 1903.

William Lucas Distant, who died on 4th January 1922, was well-known to us all by his extensive work on Indian Rhynchota to which group no less than seven volumes have been devoted in the *Fauna of India* series. He was born in 1845 and in 1867 he started on a voyage to the Malay Peninsula, where his collection of insects subsequently gave rise to his great book, "Rhopalocera Malayana : a Description of the Butterflies of the Malay Peninsula," published in 1882-86. In 1890 he went to the Transvaal, which he again visited in 1898, and his visits to South Africa are commemorated by his books, "A Naturalist in the Transvaal" (1892) and "Insecta Transvaaliensia" (1900-11). These writings show him to have been an all-round observer but his main energies were devoted to the systematic study of the Rhynchota of the World, and besides his *Fauna* volumes he produced a Monograph of the Oriental Cicadidæ (1889-92) and the part on Hemiptera of the great *Biologia Centrali-Americana* (1880—1905), as well as a very large number of shorter papers. From 1899 to 1920 he was employed as a part-time worker at the British Museum (Natural History) and during this period he rearranged the extensive material in the National Collection. We are indebted to him for the naming of a large proportion of our collection of Rhynchota.

David Sharp, M.A., M.B., F.R.S., was born on 15th October 1840 and died on 27th August 1922. Apart from his eminence as a specialist in Coleoptera, he was chiefly known to us in India as the editor since 1885 of the section on Insecta of the *Zoological Record* and for his treatise on Insects forming practically two whole volumes of the *Cambridge Natural History*. In spite of the fact that these two volumes were

written nearly thirty years ago and that many of our ideas on the classification of insects have seen many changes in the interval, they still provide a most useful introduction to the study of Entomology and, in these days of increasing specialization in all branches of entomological work, it seems doubtful whether any one author will be able to give us a more up-to-date series of volumes on the Insecta as a whole. He did not work especially on any group of Indian insects but it will be within your recollection that the Proceedings of our Third Meeting, held in this room four years ago, contained a paper from the pen of Dr. Sharp on the importance of collecting, and it was characteristic of his kindly nature and enthusiasm for the science that he loved so well that, at his advanced age and in the midst of many other occupations, he should have found the time to send us in India a message of encouragement and advice.

Hans Frühstorfer died at Munich on 9th April 1922 in his fifty-ninth year. He wrote a large proportion of the section on Butterflies in Seitz' "Macrolepidoptera of the World" and described many local races of butterflies from the Indian Region.

Henry John Elwes, J.P., F.R.S., died at his residence at Colesborne, in Gloucestershire, on 26th November 1922. He was a large land-owner with a very practical interest in farming, a great traveller and a well-known big-game hunter, and an all-round naturalist of great ability. Besides his interest in horticulture, which led him to produce his monograph of the Lilies and his great work on the Trees of the British Islands, he was keenly interested in the Lepidoptera and his monographs on the genus *Erebia*, in the Transactions of the Entomological Society for 1898, and on the genus *Parnassius*, in the Proceedings of the Zoological Society, are two excellent pieces of work on difficult groups of butterflies. In the course of his travels, Elwes visited India and collected especially in the Darjiling district and published in the Transactions of the Entomological Society for 1888 a Catalogue of the Butterflies of Sikkim. For many years he projected the idea of a catalogue of the Moths of Sikkim also and Snellen's paper on the Pyralidæ and Dudgeon's incomplete list of the Heterocera of Sikkim both contain numerous notes and additions from his pen. He was President of the Entomological Society of London for the years 1893 and 1894 and was elected to the Royal Society in 1897.

> "Stat sua cuique dies, breve et inreparabile tempus
> Omnibus est vitæ ; sed famam extendere factis,
> Hoc virtutis opus." *Æneid* X 467—469.
> 'Each hath his day. Irreparable and brief
> Is mortal life : but to spread fame by deeds
> That is man's work."

We are perhaps rather inclined to take for granted the immense mass of information which is now at our disposal regarding such a subject as Entomology, without stopping to consider how it has been acquired. Nowadays, every entomological and medical student and even a large proportion of the educated General Public is aware of the method of transmission of malaria by the bites of certain Anopheline mosquitos, and yet the facts regarding the transmission of malaria had still not been ascertained even when I first made my acquaintance with Oriental Entomology in 1896. It seems curious to re-read Mr. Joseph Chamberlain's Colonial Office Despatch, dated 6th December 1898, in which he says :— " It has been suggested .... that, in view of the possible connection of Malaria with mosquitoes, it is desirable to obtain exact knowledge of the different species of mosquitoes and allied insects in the various tropical Colonies. I will therefore ask you, if there are facilities for the purpose, to be good enough to take the necessary steps at your early convenience to have collections made of the winged insects in the Colony which bite men or animals," and to go over the literature of the succeeding years and note what an opposition there was to the acceptance of the new doctrine even after the convincing experiments by Celli, Sambon and Low in the Roman Campagna. Nowadays we all know that plague is carried by the rat-flea but we are apt to forget the years of hard work which it took to establish that one fact and we have still much to learn regarding the distribution of the various species of rat-fleas—another example, by the way, of the practical importance of systematics in applied work. Problems such as those of the transmission of *kala azar*, leprosy and surra are still in the making. In a few years time we shall probably accept their solution as a matter of fact and of every-day knowledge and conveniently forget the labours of those who have helped to solve them. It is therefore right and fitting that we should keep green the memory of those fellow-workers who have gone before us and whose labours have benefited us.

When we look back in this way and consider the already enormous past output of literature on Indian Entomology and find that many of our common insects were known over a century ago, we may be inclined to look on the study of the older authors as rather ancient history—indeed, I have heard the term " archæological research " used by some entomologists. Compared with many other branches of science of the present day, Entomology is a sturdy veteran. The beginning of Indian Entomology, as of all zoological science, was laid in 1758 by the publication of the tenth edition of Linne's *Systema Naturæ* but the first entomologist who made any extensive study of Indian insects was J. C. Fabricius who was born in 1745 and died on 3rd March 1808 (or

3rd May 1810, according to another account). Fabricius, whose autobiography will be found in the fourth volume of the *Transactions of the Entomological Society of London*, was a pupil of Linnæus and in his *Systema Entomologiæ* (1775), *Species Insectorum* (1782), *Mantissa Insectorum* (1787), and *Entomologia Systematica* (1792-98) described several hundreds of Indian insects. It is not generally known that an offer was made to Fabricius to accompany Colonel Cathcart in his voyage to the East Indian Colonies in the frigate *Venus* in 1787 but the negotiations fell through at the last minute as the East India Company refused to make any provision for his wife and family. All this may seem a long time ago, but when I first took up the study of Entomology, one of the leading English entomologists then living was Professor J. O. Westwood, who was a contemporary of Fabricius. Such a short interval as one life therefore separates us from the very earliest worker on Indian Entomology. And if such a short period of the past has yielded such results, what may we not look forward to in the future? We have vast progress yet to make in the mere collection of Indian insects of which certainly the thirty to forty thousand species that we already know are far out-numbered by those still unknown and undescribed, and in the working out of their life-histories and of their taxonomic and biological relationships. As regards applied work, we have as yet barely touched the fringe of the subject. The modern so-called control of pests is as yet merely the application of a " catch and kill " policy and I have no doubt that our successors will look on it as a very crude and wasteful effort. Control in the future will aim rather at prevention of damage by intelligent anticipation of the occurrence and increase of pests.

The list of publications on Indian Entomology is again a lengthy one and a perusal of it gives some idea of the extraordinarily diverse directions in which our insects are studied and the results published. In former years this list was published in the *Annual Report of the Board of Scientific Advice*, but two years ago the Board decided that the various bibliographies of scientific subjects should be published separately. In compliance with this order, the list of publications prepared for the year ended 30th June 1921 was extended to the end of 1921 and published as Bulletin 139, so that for future years the bibliography of Indian Entomology will correspond with the calendar year. The list of publications in 1922 is now practically completed. In these lists it is of course only possible to include those publications which come to my notice and it is at present quite impossible to secure that even the existence of all papers published on Indian insects shall be known to workers in India, owing to the large amount of obscure and unprocurable literature in which such

papers often appear. In this connection I may remind you of the resolution passed by our last Meeting regarding the desirability of the publication in India of all new literature on Indian Insects. I would also again draw attention to my remarks on this subject of Publications in my Note on the expansion of entomological work published in the Report of the Industrial Commission. It was therefore with some satisfaction that I read recently, in the newspaper reports of his Presidential Address to the Science Congress at Lucknow, the endorsement by Sir M. Visveswaraya of my ideas regarding the organization of scientific institutes and publications in India. According to this report, " he deplored the tendency to multiply them, leading to diffusedness and disorganization, instead of co-ordination and co-operation, and he emphasized the need for one accredited journal of publications for each branch of science, which would command respect in other countries, instead, as we have now, of numerous publications in every branch of scientific research "—which is exactly the opinion which I urged six years ago. As the list of recent publications is readily available for your use, I do not propose to go over it in any detail, but I cannot refrain from referring to the issue of the concluding part of Mr. Green's monumental work on the Coccidæ of Ceylon, the first part of which was issued in 1896 and of which the last part has recently appeared. It is truly a noble work of which anyone might be proud and I am sure that you will all join me in congratulating our former fellow-worker on its successful completion and also on the honour that has been paid to him by his election as the President of the Entomological Society of London for the current year.

No International Conference of Entomologists has been held since 1912 and I have heard of no proposals regarding the next Conference. The next Imperial Entomological Conference was to have taken place in 1925 but, in view of the holding of the British Empire Exhibition in 1924, it has been suggested that the Entomological Conference be held in 1924 also. The Imperial Bureau of Entomology recently inquired of me whether 1924 would suit us and I replied that the date proposed would be suitable.

Turning to the programme before us, the scope of most of the papers in Section I (Agricultural Entomology) is sufficiently indicated by their titles. We may welcome especially the inclusion of a paper such as that by Mr. Hilson on bud and boll shedding in cotton, as it is by close co-operation between the agriculturist and the entomologist that real advance is likely to be made in such problems.

I have for years urged the view that real success in economic work can only be secured if built up on a firm foundation of knowledge of the

systematics and life-history (in the widest sense of the word) of the insects concerned, and that to attain the best results from our labours the three branches of systematic, life-history and applied work must go hand-in-hand. Systematic or life-history work are each valuable in themselves and can be pursued as separate subjects, but the knowledge so attained can only be regarded as comparatively useless if merely gathered for its own sake and not applied to helping on the Great War against Waste in which we are constantly engaged with the Insect World. Economic work, considered solely by itself, tends to become mere eyewash and perfunctory routine and the so-called economic worker who "has no use for" systematic work is always liable to make serious mistakes by his failure to distinguish between closely-related insects. But if all the three branches are considered together, each will be found to afford to the others that mutual help which makes for real advances in knowledge. In this way, even the pure systematist, provided of course that the results of his work are available, may be regarded in one aspect as an economic worker of the greatest assistance to the economic worker who is not too rabidly a pure economist to despise such help. There is no need to multiply instances—all of us who have any experience are constantly coming across them—but I may perhaps take as a text for this particular portion of my sermon the title of a paper which Rao Sahib Ramachandra Rao is to read at this Meeting. The title of the paper is "A Note on a new Bollworm of Cotton in South India." This bollworm was reared at Coimbatore from cotton bolls and Mr. Ballard, who was familiar with *Diparopsis castanea* in Nyasaland, thought that the Coimbatore bollworm might be that species. I understand that Mr. Ballard only saw the larvæ and that the moths were not reared out until after he had left India. When I was at Coimbatore last December, I saw the moths reared from these bollworms and, from the rather scanty literature available there, concluded that they were not *Diparopsis*. The specimens were sent up to Pusa last month and I then re-examined them and determined them as *Rabila frontalis*, Wlk. Well, some pure economist may ask, "What does it matter whether the bollworm is *Rabila* or *Diparopsis* ? If it is not a pest, it is not worth considering; if it is a pest, its control is the only thing that matters." The reply is that the correct identification is a matter of considerable practical value, as *Rabila frontalis* was described from Ceylon in 1865 and is therefore truly indigenous in South India and presumably a mere casual destroyer of cotton-bolls whereas *Diparopsis castanea* is a regular bollworm in South Africa but not hitherto known to occur in India. Point is added to this by the fact that there have lately been large importations of cotton-seed into Western India from South-East Africa

and one of the pests which is likely to be brought in in such shipments is *Diparopsis*. If the Coimbatore bollworm had turned out to be *Diparopsis*, it would have shown that we were already too late to keep it out of India. Happily, that is not the case, and we may still hope that *Diparopsis castanea* will not secure permanent admission to our already long list of crop-pests.

In Section II (Forest Entomology), Dr. Beeson proposes to let us have a glimpse at the extremely interesting subject of forest pests, many of which are the same or very similar to those agricultural pests with which we have to deal. In Section III (Medical and Veterinary Entomology), we welcome a paper by Mr. Timoney as the first contribution to one of our Meetings by a member of the Veterinary Service. In Section VIII (Life-histories and Bionomics) Major Hingston, whose book *A Naturalist in Himalaya* is well-known to you, is contributing a paper on the evolution of the faculty of communication in Ants. In Section X (Systematic Entomology) there are several papers which promise to be very interesting and I may specially call your attention to Rao Sahib Ramachandra Rao's paper on the extraordinary structure of the sexual armature of certain Anthomyiad Flies. The importance of a study of these elaborate structures is becoming more and more realized in connection with the identification and classification of insects and it is probable that future work in this direction will reveal in many cases an unexpected complex of species really diverse but superficially identical. The various species of the genus *Sarcophaga*, for example, cannot at present be separated on external characters, but Mr. Senior-White, who is at present working on the Indian forms of this group, has been able to separate out about thirty species which are distinct by the structure of the armature. In Section XI (Publications and Organization) Dr. Kunhi Kannan wishes to bring forward a resolution regarding the teaching of Entomology in the Universities. Whilst we cannot doubt that a spread of knowledge regarding Insects is of the greatest value, not only to the individual, but to the country at large, I fear that little can be accomplished by a resolution which is likely to remain a pious expression of our opinion without any executive authority. So far as one hears, most of the Universities have at present as much as they can do to balance their Budgets without taking up any new subjects. That the subject of cooperation in Indian Entomology appeals to you is seen by your presence here and in my paper I shall ask you to consider how this can best be attained and developed, how we at Pusa can best help the Provincial Staffs and *vice versa* and how the Provincial Staffs can best help one another. Of course, I recognize that here again we come on what may

be rather pious expressions of opinion without any executive authority, but, provided we bear that in mind, I think that a discussion on such a subject will be useful. Publicity for Entomology in India seems to me required for further advance and I shall be grateful to you for your discussions of this paper regarding the best method of securing it. In Section XII (Miscellaneous) Dr. Kunhi Kannan proposes to tell us something about entomological work in the United States, which he has lately visited. We should all be glad to have a chance of seeing their work at first-hand, as we read so much about it, and in the meantime we look forward to this lecture on the subject. The United States provide an example of a country which takes entomological work really seriously, the appropriation to the Bureau of Entomology totalling over seven million rupees during the current year.

Mr. Ghosh has sent in a paper on "A few insects used as food in Burma," and we are all familiar with occasional examples of the use of insects as human food. The ancient Romans regarded the *Cossus* as a delicacy but it is probable that their *Cossus* was the larva of a longicorn beetle and not the evil-smelling larva of *Cossus cossus*. I have heard that palm-weevil grubs are eaten with relish in the West Indies, and the Australian aborigines' feasts on the *bugong* moth are also well-known. In the translation of Koenig's paper on Termites, included in the Report of our Fourth Meeting, Koenig referred to the custom of catching the winged termites for use as food and I have described the procedure as carried out in the Coimbatore district at the present day. You will, however, readily understand that insects when taken as food can only be eaten occasionally, either by themselves or with other kinds of food, as man is too bulky an animal to be wholly insectivorous. But, besides their use as food, insects are sometimes eaten by man for other purposes. Koenig, for example, in his paper mentions that the *Kuli*-classes around Tranquebar "as soon as they come across a queen termite by chance through the breaking down of old buildings constructed of earth or in other places whilst digging, at once swallow her alive; with the idea that it strengthens their spinal nerves and gives great vigour." I have heard of this practice in other parts of India where a queen termite is swallowed for its supposed aphrodisiac qualities. Now, this is not a case where an insect is used as food. It is a case of Homœopathic or Imitative Magic, a pseudo-science which commits the mistake of supposing that things which resemble each other are the same, so that any desired effect may be produced merely by imitating it. In pursuance of such an idea, the Namaquas in Africa abstain from eating the flesh of hares, because they think it would make them faint-hearted as a hare, but they eat the flesh of the lion, or drink the blood of the leopard or lion, to get

the courage and strength of these beasts. In Northern India people fancy that if you eat the eye-balls of an owl you will be able to see like an owl in the dark. The Miris of Assam prize tiger's flesh as food for men, to give them strength and courage, but they say that it is not suited for women, as it would make them too strong-minded. In Morocco lethargic patients are given ants to swallow to make them more lively. By the same false analogy, the extreme fertility of the queen termite is supposed to be communicated to the man who swallows the insect.

The association of insects with magical powers and magical rites has been dealt with more or less incidentally in Sir James Frazer's well-known book, *The Golden Bough*, but as the subject is interesting and probably unfamiliar to most of you, you will perhaps pardon me if I enter into it at least briefly, in order to stimulate your interest to record further examples in India should you come across any. The principles of thought on which magic is based resolve themselves into two, the Law of Similarity, that like produces like, or that an effect resembles its cause, and the Law of Contact or Contagion, that things which have once been in contact with each other continue to act on each other at a distance after the physical contact has been severed. Charms based on the Law of Similarity may be called Homœopathic or Imitative Magic. Charms based on the Law of Contact or Contagion may be called Contagious Magic. Magic is therefore a spurious system of natural law as well as a fallacious guide of conduct: it is a pseudo-science as well as an abortive art. Magic may thus also be divided into theoretical, dealing with a statement of the rules which determine the sequence of events, and practical, comprising the precepts which human beings observe in order to compass their ends. The pseudo-art of practical magic may be sub-divided into positive magic or sorcery and negative magic or taboo. Positive magic or sorcery says, " Do this in order that so and so may happen." Negative magic or taboo says, " Do not do this, lest so and so should happen." The aim of positive magic or sorcery is to produce a desired event; the aim of negative magic or taboo is to avoid an undesirable one. We have just had an example of sorcery in the swallowing of the queen termite. In other cases sympathetic magic may be systematically carried into practice for the maintenance of the food supply. Thus, among the Arunta tribe of Central Australia the men of the witchetty-grub totem perform ceremonies for multiplying the grub which the other members of the tribe use as food. One of the ceremonies is a pantomime representing the adult insect in the act of emerging from the pupal stage. A long narrow structure is set up to imitate the pupal case of the insect and in this structure a number of men, who have the grub for their totem, sit and sing of the creature in its various stages.

Then they shuffle out of it in a squatting posture and as they do so sing of the insect emerging from the pupa. This is supposed to multiply the numbers of the grubs.

Animals are often supposed to possess qualities or properties which might be useful to man, and homœopathic or imitative magic seeks to communicate these properties to human beings in various ways. Thus some Bechuanas wear a certain insect, mutilated, but living, because, since it is very tenacious of life, it will make them difficult to kill. To bring back a runaway slave an Arab will trace a magic circle on the ground, stick a nail in the middle of it, and attach a beetle by a thread to the nail, taking care that the sex of the beetle is that of the fugitive. As the beetle crawls round and round, it will coil the thread about the nail, thus shortening its tether and drawing nearer to the centre at every circuit. So by virtue of homœopathic magic the runaway slave will be drawn back to his master.

Sometimes homœopathic or imitative magic is called in to annul an evil omen by accomplishing it in mimicry, the idea being to circumvent destiny by substituting a mock calamity for a real one. In Madagascar this mode of cheating the fates is reduced to a regular system. Here every one's fortune is determined by the day or hour of his birth, and if that happens to be an unlucky one his fate is sealed, unless the mischief can be extracted by means of a substitute. The ways of extracting the mischief are various. Thus, if fate has decreed that a young girl, still unwed, should see her children, still unborn, descend before her with sorrow to the grave, she can avert this calamity as follows. She kills a grasshopper, wraps it in a rag, to represent a shroud, and mourns over it like Rachel weeping for her children and refusing to be comforted. Moreover, she takes a dozen or more other grasshoppers, and having removed some of their superfluous legs and wings she lays them about their dead and shrouded fellow. The buzz of the tortured insects and the agitated motions of their mutilated limbs represent the shrieks and contortions of the mourners at a funeral. After burying the deceased grasshopper she leaves the rest to continue their mourning until death releases them ; and having bound up her dishevelled hair she retires from the grave with the step and carriage of a person plunged in profound grief. Thenceforth she looks forward cheerfully to seeing her children survive her; for it cannot be that she should mourn and bury them twice over.

As an example of negative magic or taboo we may refer to the fact that in some parts of Laos, in Annam, all who engage in the practice of gathering lac abstain from washing themselves and especially from cleansing their heads, lest by removing the parasites from their hair

they should detach the lac insects from the trees. Among taboos none are perhaps so important or numerous as the prohibition to eat certain foods. Just as the savage eats many animals or plants in order to acquire certain desirable qualities with which he believes them to be endowed, so he avoids eating many other animals and plants lest he should acquire certain undesirable qualities with which he believes them to be infected, and in this abstention he practises negative magic. Thus, the Bushmen of South Africa will not give their children a jackal's heart to eat, lest it should make them timid like the jackal, and the Namaquas abstain from eating the flesh of hares, because they think that to do so would make them faint-hearted like hares. Similarly among the Fans of West Africa men in the prime of life never eat tortoises; they imagine that if they did so they would become heavy and stupid like a tortoise and that their vigour and fleetness of foot would be gone. But old men may eat tortoises freely, because, having already lost the power of running, they can take no harm from the flesh of the slow-footed creature. I do not know of any instance of abstention from insect food on similar grounds, but doubtless such cases may exist.

Magic is closely allied to primitive religion, and by religion we may understand a propitiation or conciliation of powers superior to man which are believed to direct and control the course of nature and of human life. Thus defined, religion consists of two elements, a theoretical and a practical, namely, a belief in powers higher than man and an attempt to propitiate or please them. Belief without practice is not religion but theology, and practice without belief is not religion. The aim of religious practice is to conciliate or persuade the deity, hence it is not necessary that it should always take the form of a ritual, such as the offering of sacrifice, or the uttering of prayers, or other outward ceremonies. But if religion involves, firstly, a belief in superhuman beings who rule the world, and secondly, an attempt to win their favour, it clearly assumes that the course of nature is to some extent elastic or variable and that we can persuade or induce the mighty beings who control it to deflect, for our benefit, the current of events from the channel in which they would otherwise flow. Now, this implied elasticity or variability of nature is directly opposed to the principles of magic as well as of science, both of which assume that the processes of nature are rigid and invariable in their operation, and that they can as little be turned from their course by conciliation and entreaty as by threats and intimidation. Religion, as a conciliation of the superior powers, assumes that the forces that govern the world are conscious and personal and that the conduct of the governing being is in some measure uncertain and that he can be prevailed upon to vary it in the desired direction by a

judicious appeal to his interests, his appetites or his emotions. Magic, on the other hand, assumes that the forces which govern the world are unconscious and impersonal. It is true that magic often deals with spirits, which are personal agents of the kind assumed by religion ; but whenever it does so in its proper form it treats them exactly as it treats inanimate agents, that is, it constrains or coerces instead of conciliating or propitiating them as religion would do. Thus it assumes that all personal beings, whether human or divine, are in the last resort subject to those impersonal forces which control all things, but which nevertheless can be turned to account by anyone who knows how to manipulate them by the appropriate ceremonies and spells. In ancient Egypt, for example, the magicians claimed the power of compelling even the highest gods to do their bidding and actually threatened them with destruction in case of disobedience.

You will think that this is rather outside of Entomology but it was necessary to consider such cases before coming to the question of the common practice of the control of crop-pests in India by the use of *mantrams* or spells. As most of you are aware, such methods of control are used not uncommonly when crops are attacked by insect pests and they are often looked upon as quite efficacious by those who employ them. But what I want to point out is that their employment is another example of the use of magic in connection with insects. Of course, amongst peoples at an early stage of civilization the functions of priest and sorcerer were often combined or, to speak perhaps more correctly, were not yet differentiated from one another, and the same confusion of magic and religion has survived to the present day amongst peoples who have risen to higher levels of culture. We find therefore that the spells originally launched to coerce the superhuman being responsible for the control of insect plagues may develop into exorcisms, either spoken or written, made in the name of a deity.

Sometimes the desired end of reducing loss by the insect pests affecting his crops and his cattle is attained by primitive man by conciliating them by worship or sacrifice. To rid himself of these destructive foes, the farmer has recourse to many superstitious devices, of which, though some are meant to destroy or intimidate the pests, others aim at propitiating them and persuading them by fair means to spare the fruits of the earth and the herds. Thus, Esthonian peasants in the island of Oesel stand in great awe of the grain weevil. They give it a fine name and, if a child is about to kill a weevil, they say, " Don't do it ; the more we hurt him, the more he hurts us." If they find a weevil they bury it in the earth instead of killing it. Some even put the weevil under a stone in the field and offer corn to it. They think that thus it is appeased

and does less harm. Amongst the Saxons of Transylvania, to guard the corn against the attacks of leaf-flies (Aphids, presumably), the sower shuts his eyes and scatters three handfuls of oats in different directions. Having made this offering to the insects, he feels sure that they will spare the crop. Another Transylvanian way of securing the crops against pests is this : after he has finished sowing, the sower goes once more from end to end of the field imitating the gesture of sowing, but with an empty hand. As he does so he says, " I sow this for the animals ; I sow it for everything that flies and creeps, that walks and stands, that sings and springs." The pests are supposed to be satisfied with this their portion and to refrain from attacking the rest of the crop.

Sometimes the desired object is supposed to be attained by treating with high distinction one or two chosen individuals of the obnoxious species, while the rest are pursued with relentless vigour. When the farms of the Sea Dyaks or Ibans of Sarawak are much pestered by birds and insects, they catch a specimen of each kind of vermin (one sparrow, one grasshopper, and so on), put them in a tiny boat of bark well stocked with provisions, and then allow the little vessel with its obnoxious passengers to float down the river. If that does not drive the pests away, the Dyaks resort to what they deem a more effectual mode of accomplishing the same purpose. They make a clay crocodile as large as life and set it up in the fields, where they offer it food, rice-spirit, and cloth, and sacrifice a pig or fowl before it. Mollified by these attentions, the ferocious animal very soon gobbles up all the pests that are destroying the crops ! In Albania, if the fields or vineyards are ravaged by locusts or beetles, some of the women will assemble with dishevelled hair, catch a few of the insects and march with them in a funeral procession to a spring or stream, in which they drown the creatures. Then one of the women sings, " O locusts and beetles who have left us bereaved," and the dirge is taken up and repeated by all the women in chorus. Thus, by celebrating the obsequies of a few locusts and beetles, they hope to bring about the death of them all.

In some cases the expulsion of pests (which may be considered to take the form of devils) may take place periodically. Thus, in India the Khonds expel the devils at seed-time, when they worship Pitteri Pennu, the god of increase and of gain in every shape. On the first day of the festival a rude car is made of a basket set on a few sticks, tied upon bamboo rollers for wheels. The priest takes this car first to the house of the lineal head of the tribe, to whom precedence is given in all ceremonies connected with agriculture. Here he receives a little of each kind of seed and some feathers. He then takes the car to all the other houses in the village, each of which contributes the same things. Lastly, the

car is conducted to a field outside the village, attended by all the young men, who beat each other and strike the car violently with long sticks. The seed thus carried out is called the shares of the " evil spirits, spoilers of the seed." These are considered to be driven out with the car ; and when it and its contents are abandoned to them, they are held to have no excuse for interfering with the rest of the seed.

Such are a few instances of the connection between Insects and Magic, as given in Frazer's *The Golden Bough*. It would be interesting if any of you could secure further examples of practices with regard to the magical uses of insects or their control. Probably many such cases are to be found in India but are overlooked as superstitious usages of little interest to anybody ; but yet, if collected together and recorded, they are often of great interest in the study of Magic and Religion.

I.—NOTES ON PESTS INVESTIGATED IN MADRAS DURING THE YEARS 1921-22.

By Rao Sahib Y. RAMACHANDRA RAO, M.A., F.E.S., *Acting Government Entomologist, Madras.*

The pests of a province vary in importance in different years. The major pest of one year may sink into insignificance the next year, whereas another usually of no importance whatever may shoot into sudden and unexpected prominence. There are again certain pests which remain destructive in all years with but little variation. Viewed from this aspect, a comparison of records of pests of successive years will have a true educative value.

Pests of 1921-22 may be conveniently viewed under the following three heads :—

I. Detailed investigation.
II. Demonstration work and campaigns.
III. Miscellaneous.

I.—DETAILED INVESTIGATION.

(1) *Platyedra gossypiella*, the Pink Bollworm, and (2) *Pempheres affinis*, the Cotton Stem Weevil, have been receiving much attention at Coimbatore since 1919, with reference to a determination as to the degree of efficacy of the Enforcement of the Pest Act against the aforesaid pests on Cambodia cotton in South India. Whereas from the rather imperfect way the Act is enforced, it is evident that the Stem Weevil has not been checked to any great extent, so far as the Pink Bollworm is concerned it is unanimously agreed that the *Kapas* received at the market, especially the produce of the first picking, has very greatly improved in quality. Since 1922, however, the date of enforcement has been changed from 31st July to 31st August, and although thisc hange has satisfied the ryots, it is feared that it will affect the efficacy of the working of the Pest Act.

Results of investigation on these two pests by Mr. E. Ballard are under publication as Pusa Bulletins.

(3) *Schœnobius incertellus*. Results of experiments conducted in the Kistna District in 1920-21 by Mr. Ballard are being published as a memoir. Work is now transferred to the Government Farm, Samalkota,

where experiments on the same lines are being continued, and observations as to certain details of life-history, parasites, etc., are also being made. From actual countings taken, it is becoming more and more evident that this insect is not such a serious pest really as it appears at first sight.

(4) *Calocoris angustatus* was reported to have been very serious in Bellary and the Ceded Districts generally in 1921 and the infestation was evidently so bad as to merit serious discussion at one of the sessions of the Madras Legislative Council. The life-history of the pest has been completely investigated, but no clue has yet been discovered for evolving practicable remedies. The only way of dealing with the pest would appear to be through cultural methods. A uniform crop favoured by seasonable rain and weather would appear not to mind the pest at all, whereas an uneven crop sown at different times and maturing unevenly offers the optimum conditions for its increase, and the early as well as the late-sown crops suffer. The insect becomes a serious pest chiefly on account of the rapidity of its increase. Experiments on cultural lines have been devised by Mr. Ballard and are under trial at Coimbatore.

(5) *Eelworm in Betel vine.* Since 1909 there have been complaints of a decrease of yield among the betel vine gardens in the Noyyal valley. Earthworms, which are present in large numbers in the soil, were supposed to damage the roots by their extensive burrowings and were moreover also regarded as depriving the plants of the farm-yard manure applied by the *raiyats.* The problem was under investigation for a long time, and in 1921-22 it had further the honour of receiving attention at some of the sittings of the Madras Legislative Council. As a result of recent investigation the presence of Root Knot Eelworm (probably *Heterodera radicicola*) has been found in most of the gardens and it is probable that the whole question is connected more with the Eelworm than the Earthworm. Manurial experiments have been devised in consultation with the Government Agricultural Chemist and the Deputy Director of Agriculture, VIII Circle, and the experiments will be carried out by the latter in some of the affected gardens.

(6) All pests on plants in the Agricultural College Botanical Garden, Coimbatore, were kept under observation for one full year and remedies were systematically studied. Results of observations are proposed to be published as a bulletin for the use of gardeners.

(7) *Ragmus morosus*, Ballard, and *R. flavomaculatus*, Ball., are small Capsid bugs found on cotton and were described, as they proved to be new species, in the *Indian Museum Records* (1922). These bugs, especially *R. morosus*, were regarded as mainly responsible for the bud and boll fall of cotton, as they were supposed by their punctures to give

entrance to certain Bacteria causing internal bud and boll rot. An article on the subject has appeared under the joint authorship of Mr. E. Ballard and Mrs. Dorothy Norris in the *Agricultural Journal of India*

The life-history of *Ragmus morosus* and *R. flavomaculatus* was fully worked out by the writer in 1921 in this connection.

II.—Campaign work and Demonstration.

(1) *Nephantis serinopa*. A serious attack on coconut was reported from Mangalore in 1922 and has engaged the attention of several of the members of the Agricultural Department, both of the Entomological and Agricultural sections, for some months since July 1922. The assistance of the Pest Act had to be invoked ultimately as some of the garden owners would not consent to have their trees treated. A separate paper is being read on this subject.

(2) *Mango-hopper* (*Idiocerus*). For the last few years mango-hopper work was not taken up for want of staff. This year, in spite of the same difficulty, an area in the IV Circle in the Chittoor District has been taken for demonstration at the urgent request of the Deputy Directer of Agriculture, IV Circle. Work is now under progress.

(3) *Hairy caterpillars* on *cumbu*. Work was taken up to demonstrate hand-picking of moths, but proved unsuccessful as work was started too late.

III.—Miscellaneous.

(1) *Heliothis obsoleta* has become a regular bollworm of Cambodia cotton, especially in the case of young bolls. The percentage of infestation is sometimes as high as 3·35 per cent. It generally disappears after March, but in 1922 there was a recrudescence in May.

(2) *Rabila frontalis*. A new cotton bollworm is now added to the list of cotton pests. The pest is a Noctuid caterpillar which feeds on the interior of the young boll and entirely scoops it out, thus resembling in its habits the African Bollworm (*Diparopsis castanea*). The pest was first discovered by Mr. Ballard in 1920, but moths were reared out only in December 1922 and were kindly determined by Mr. Fletcher. The insect is not, however, a serious pest. A separate note on this subject appears elsewhere.

(3) *The Rice Stem Fly* was first discovered by Mr. Ballard in 1920 and large numbers were reared in 1921, when its life-history was also worked out. It has since been found to breed also in local varieties of wheat. It is quite distinct, as determined by the male genitalia, either from the *cholam* or the *cumbu* Fly.

(4) *The Rice bug. Leptocorisa varicornis* was reported in October 1922 on *Setaria italica* from Gooty, Anantapur District.

(5) *Laphygama exigua* was found badly damaging nurseries of *Ragi* (*Eleusine coracana*), a crop on which it has not yet been recorded. Poison baits and flooding, accompanied by the kerosining of the irrigation water, were found more successful than spraying.

(6) *Fruit moths. Ophideres* spp. were found damaging an orchard in the Kistna District and the results of the investigation appear as a separate paper.

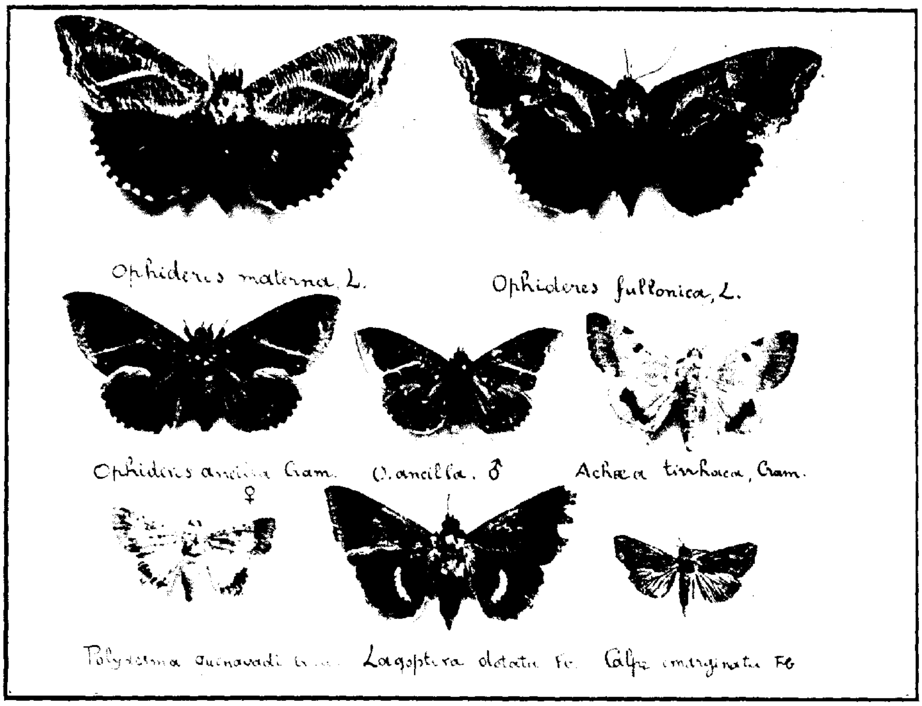
(7) *Contarinia andropoginis*. Felt, was found to be rather serious to late-formed earheads of *Sorghum* in July 1922. The fly lays eggs in the flowers and the maggot (of which as many as five were found in a single flower in one case) attacks the young grain and causes it to abort. In some cases entire earheads were transformed into chaff.

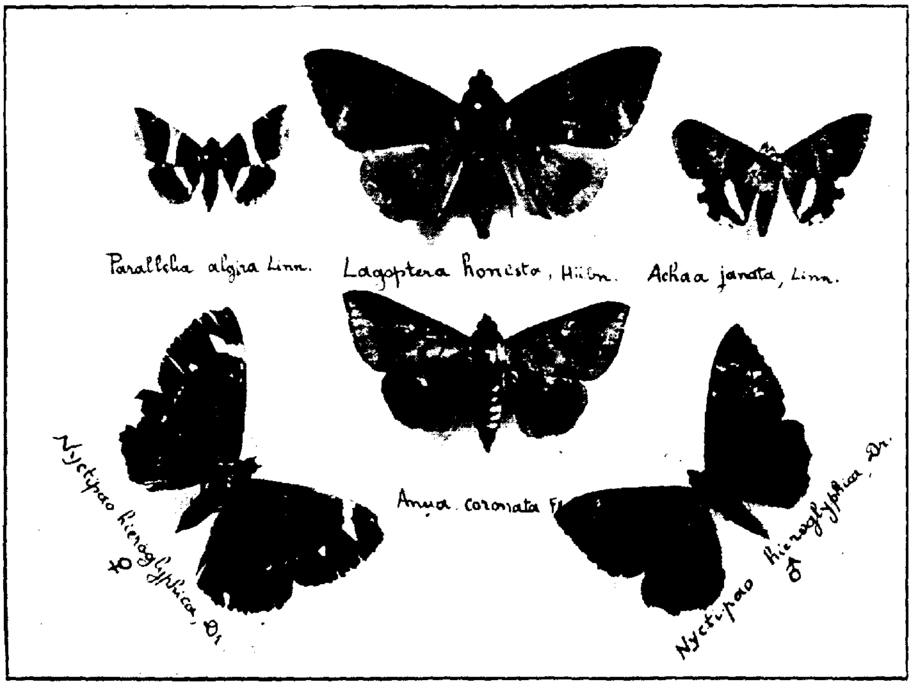
(8) *Rubber bark caterpillar* (*Aetherastis circulata*) is a small bright-red flattened caterpillar about an inch in length when fully grown. It feeds under a web on the bark of Rubber trees either on the renewing bark or on other parts of the tree, generally at a height of about three feet from the ground, up to the region of the first branches. Its distribution is probably universal in Travancore and Cochin, as it was seen at Mooply, Peermade (not on rubber) and Tenmalai. (Ballard—*Planters' Chronicle*. 15th July 1922.) There would appear to be two broods in the year between January and May. The caterpillar protects itself under a silk web covered with bark chippings and pupates in an oval silken cocoon "under a piece of bark." The moth emerges in about ten days as a small white insect with minute black spots on the wings.

(9) *Spodoptera* sp. was reported to be devastating grass lands in S. Kanara in 1921.

(10) *Yerra Tegulu*. This is a serious disease of paddy noted in the Northern Circars, causing a premature drying of plants and a stunting of earheads in paddy. It was investigated by Mr. Ballard and Assistant Mr. P. N. Krishnan. It was first supposed to be due to Eelworm attack, as eelworms had been noted in the grains, etc., in certain cases. Ultimately, however, owing to a failure to induce the disease in pot plants by inoculation, the disease was concluded to be not due to Eelworm attack.

(11) Rats were found attacking the root stocks of lucerne on the Central Farm, Coimbatore, and causing the plants to dry up.





Noctuid Moths attacking fruits in South India.

2.—FRUIT SUCKING MOTHS OF SOUTH INDIA.

By P. SUSAINATHAN, F.E.S., *Assistant in Entomology, Coimbatore.*

(Plates 1 and 2)

An influential garden owner in the vicinity of Chintalapudi, Kistna District, reported damage to his citrus and pomegranate fruits towards the end of July 1922 and investigations in the tract proved that the agents responsible for the damage were certain Noctuid moths, *Ophideres* spp., etc., which, being possessed of stout saw-like proboscides, were able to puncture all sweet fruits with a soft rind, such as oranges, mangoes, etc., and (astonishing to record) even pomegranates. The moths started flying about at dusk at about 7 P.M. and alighted on the fruits, in the present case on oranges, *ripe* or *unripe*, and ripe pomegranates. Some moths have been observed to rest in the same situation on the fruit for over an hour, although the longest period of feeding has not been noted. The moths are found hovering about the fruit trees throughout the night, returning at day-break to their hiding places among thick bushes and in the interior of leafy mango trees. During the day time, if disturbed, they exhibit a curious low blundering flight and get under cover almost immediately into the nearest bush or tree.

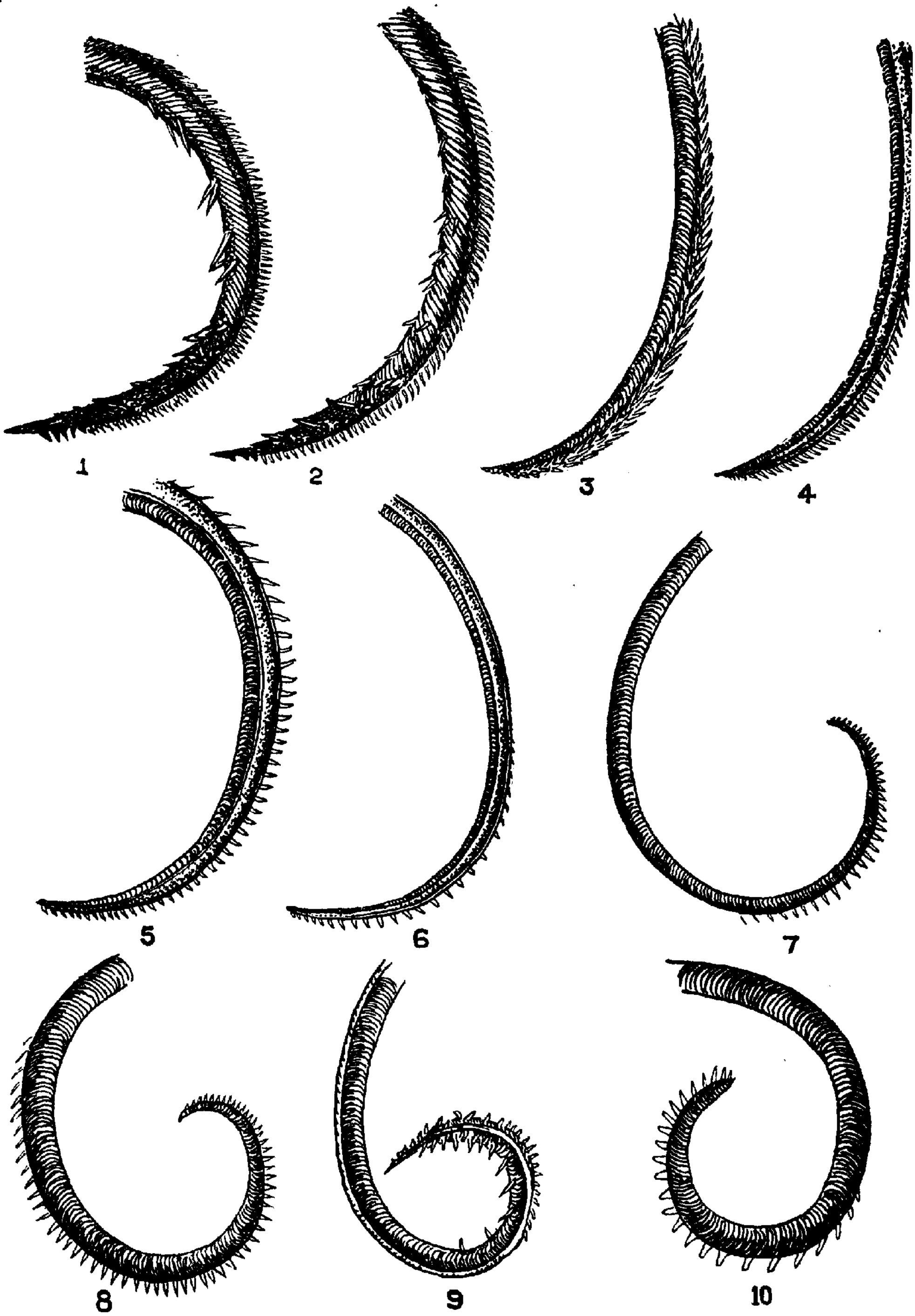
The *Ophideres* moths which are found to attack fruits in the present instance are chiefly of two species, *viz.*, *Ophideres fullonica*, Linn., and *Ophideres materna*, Linn., both of which have been definitely observed to puncture fruits. Two solitary specimens, however, of *Ophideres ancilla*, Cram., which is found occasionally in Coimbatore, were caught in the tract. These start by thrusting their proboscides into the fruits. When the first hole has been drilled into the fruit tissue, more holes are bored later on and sometimes 20 to 22 or even 25 holes have been found on a single ripe pomegranate fruit. Usually 9 to 10 is about the average, although some fallen fruits have been observed to have 2 or 3 holes and rarely one. The holes are quite small, clearly seen on pomegranates, but almost invisible on oranges due to the nodosities on the surface of the fruit. A fallen orange could be easily examined for *Ophideres* attack, for if one squeezes the fruit in the palm of the hand, minute frothy jets of the fermenting juice will escape from the rind of the fruit, if attacked, whereas in the case of fruits that have fallen on account of some physiological or other cause such exudations do not occur. When a fresh orange is attacked, the

owner states, it takes three or four days for the fruit to rot and fall. Possibly it takes more time, as much depends on the virulence of the attack and the number of holes drilled into a particular fruit. Pomegranate fruits when tender are left undisturbed but full-grown pomegranates and ripe and unripe oranges and sweet limes are readily attacked.

Scores of other moths come out at night and alight on damaged fruits, both on the shed ones and on those attached to the tree, although the fruits on the trees form a surer attraction than those on the ground, but even *Ophideres* does not disdain fruits on the ground. Of these moths it is almost certain that *Ophideres* is the chief pest, although I suspect that certain other large Noctuids are also implicated, *e.g.*, *Anua coronata*, Fb., *Lagoptera honesta*, Hubn., *Lagoptera dotata*, Fb., *Lagoptera submira*, Wlk., *Anua* (*Achæa*) *tirrhaca*, Cram., *Anua mejanesi*, Guen., etc. Of these, *Anua coronata* resembles *Ophideres* in colour, size and build. But the proboscides of all these moths in no way resemble the saw-and-file-like organ of *Ophideres*. The smaller moths, such as *Achæa janata*, Linn., *Ercheia diversipennis*, Wlk., *Parallelia algira*, Linn., *Polydesma quenavadi*, Guen., *Pelamia frugalis*, Fb., *Pericyma glaucinans*, Guen., and *Simplicia robustalis* swarm round the damaged fruits, both on the ground and on the trees, but *Calpe emarginata*, Fb., does not appear to descend to the ground.

Calpe ophideroides, Guen., has been recorded as a destructive pest of nectarines and peaches in the Kumaon Government Gardens, the moths piercing and sucking the fruit in exactly the same way as *Ophideres fullonica* (*vide* page 45. *Annotated List of Indian Crop pests* by Fletcher, also Entomological Note 64, Pusa Bulletin No. 59). *Nyctipao hieroglyphica*, Drury, has not been observed to go up trees but usually swarms on fallen fruits and is attracted to jaggery syrup spilt on the ground or smeared on tree trunks. Moths of the type of *Nyctipao* appear to be quite harmless and settle on the fruits merely for the sake of the oozings and I do not think that they make any original punctures.

A series of experiments was undertaken in the Kistna District by way of control measures against these fruit-sucking moths. Poison-baiting was one of the measures tried to kill off the moths with some success. Slips of mango fruit were steeped for an hour or so in a thick solution of (i) sodium arsenate, (ii) Paris green and were exposed in the open, overnight, and also strung together with thin rope and tied on to the branches on pomegranates and orange trees. As control, other unpoisoned slips were also hung up in strings on top of the trees. It was found on several nights that the moths carefully avoided the poison-baits but swarmed on the unpoisoned ones. The dosage of poison was reduced but without any effect, the moths sedulously avoiding the poisoned bits



Tips of proboscides of fruit-sucking moths from South India :—

1, *Ophideres fullonica*; 2, *O. materna*; 3, *Anua coronata*; 4, *Lagoptera dotata*; 5, *Achaea tirrhaca*; 6, *A. janata*; 7, *Parallelia algira*; 8, *Polydesma quenavadi*; 9, *Calpe emarginata*; 10, *Nyctipao hieroglyphica*.

of mango. The same experiment was tried with jaggery syrup mixed with arrack (country spirits) with more encouraging results. Four per cent. by volume of sodium arsenate was used. The poison-bait was also mixed with some essential oils, such as Oleum aurantiæ, Oleum verbenæ, Oleum lemonis and Essentia anonæ. There was slight attraction to the smell of the pine apple (Essentia anonæ) to which these moths were attracted, especially *Polydesma quenavadi* which was conspicuous by its presence in fairly large numbers, but I cannot say if *Ophideres* preferred this. When more arrack was used, instead of the essential oils, the best results were obtained. Most of the captures from the alcoholized poison-baits were separately marked and kept to observe the effects of the poison. There is clear evidence to prove that the moths which feed on the poison surely succumb within 24-36 hours. A few were even picked up the next morning either moribund or dead. Plain jaggery syrup applied with a rough brush to the trunks of trees did not attract so many moths as the alcoholized mixture. Most of the moths taken at plain jaggery syrup to which arrack was added were found drunk and unresponsive to external stimuli and apparently moribund, but recovered about 5 to 10 hours later; none succumbed, however. Unfortunately, these very interesting sets of poison-baiting experiments had to be necessarily stopped as the moths ceased to appear in numbers in the orchard and disappeared altogether later on. There is perhaps more hope of success in poison-baiting, especially by sodium arsenate, than in any other control method.

Handnetting is really an efficient check. Before my arrival on the estate the garden-owner had been trying his best to capture the moths. He had some ripe mangoes split up into a number of pieces which he exposed on the ground in the vicinity of the fruit trees. He had five or six such traps. A man used to go round with a fishing net till about 9 or 10 P.M. and he caught as many moths as he possibly could with the help of a fishing net. The captured moths were squeezed to death. The method although cumbersome was effective in a way. On my arrival on the estate, further handnetting was done extensively, with the result that owing to this efficient mechanical method the pest was kept within bounds.

Protecting the fruits with masks is another effective, if costly, method. The garden-owner was in the habit of tying up each fruit with a lotus leaf girt round and sustained by a string. This, as far as I can see, appears to be efficacious but the fruits are atrophied for want of aeration and sunshine and there comes the question of labour and cost of the leaves which had to be brought down from a long way off and the impossibility or impracticability of tackling every fruit in a big orchard. Where

there are accidental slits on the leaves the moth is sure to puncture the fruit.

It would appear that the dry lotus leaf has some property of keeping off the moths. It is unimaginable that when fruits like pomegramates which have a hard rind are punctured by the moths a soft rinded fruit like the orange, with a leaf mask on, should keep the moths off. It is certainly not the toughness of the lotus leaf. Several fruits were then experimentally screened with the lotus leaves and these successfully kept away the moths. The dry lotus leaves appear to keep off the moths probably due to their property of emitting a sort of nicotine smell. But, of course, this is not the last word on the subject.

Spraying, although primarily not valuable as a moth killer, still could be tacked on as an auxiliary method in conjunction with poison baiting, handnetting, masking, etc. In fact, spraying could be used as a deterrent against the moths that come to pay their attention to the fruits. Three substances were sprayed on both pomegranates and oranges.

(a) *Crude oil emulsion.* This substance was sprayed at a strength of 1 lb. in 8 gallons of water and the first set of trees was done on 4th August 1922, trees which were noted to be virulently attacked by *Ophideres* on the previous night. For each set of sprayings we had unsprayed trees as controls. On the sprayed trees, there was a visible diminution in the number of moths and this continued for four days when the shedding considerably improved. It was quite clear that the moths had a great dislike for the odor of crude oil and they avoided the sprayed trees. With such encouraging results, more trees were sprayed with success.

(b) *Fish oil soap.* A big sweet lime tree, found to be very seriously visited by the moths on the night of 4th August 1922, was sprayed with Fish oil soap on the next evening at a strength of 1 lb. of soap in 8 gallons of water. This tree was almost free on the sprayed night, but on the second night after the spraying, already the moths were again turning up in numbers and later on the shedding of the fruits did not cease. More orange and pomegranate trees were subsequently sprayed with Fish oil soap, the results being almost the same, *i.e.*, no moths or at any rate not many for the first one or two nights and a recurrence of the attack later on. Hence it was found that Fish oil soap was not so effective in keeping the moths from visiting the trees.

(c) A few trees were also sprayed with a strong solution of tobacco decoction to which resin had been added in the proportion

of 1 lb. to 4 gallons of stock. The mixture was diluted and sprayed on the trees in the evening. The odour of tobacco was characteristic but it could not be said that this spraying gave results as encouraging as crude oil emulsion in repelling the moths after the second night.

Spraying, although not very efficient on the whole, may be tried as a sort of deterrent when the moths are numerous; this when employed along with sugaring is certain to repel the moths from the sprayed trees and induce them to betake themselves to the molasses baits.

But the main solution to the problem would appear to depend on the evolution of a mixture of poisoned molasses which must possess the properties of being a surer attraction to the moths rather than the fruits themselves as well as of being sufficiently toxic to kill off the moths in numbers, preferably on the spot.

In a recent number of the *Journal of Economic Entomology* there was a description of an apparatus used for poison-baiting moths, which might be of use in such cases. It consisted essentially of an inverted bottle, contained poisoned sugar solution, and provided with a piece of wick passed through the cork. The bottles are suspended so that the evening sun strikes on them, the expansion of the air inside the bottle forcing out a certain amount of the bait onto the wick.

3.—SOME IMPORTANT PESTS OF THE MALAY PENINSULA.

By P. SUSAINATHAN, F.E.S., *Assistant in Entomology, Coimbatore.*

Opportunity was taken of a private visit in September-December 1922 to French Cochin-China as well as to the Malay Peninsula, to study the local insects, mostly those affecting cultivated crops in the tract. But before writing up these short notes, it may not be out of place to review briefly the nature of the Entomological work carried on in these two countries.

Saigon, the Capital of Cochin-China, is also the headquarters of the "Services Scientifiques" which include Entomology. The Entomological branch of the Scientific Institute is in charge of Monsieur Vitalis de Salvaza, who, during the time of my visit, was on long leave in France. In the interim the Section is managed by a brother officer who was mainly engaged in the cultural study of the Liberian coffee, with a view to evolve a hardy variety that easily withstands the attack of *Xylotrechus quadripes*, Chev., quite a serious pest of coffee in this region. Control experiments against the beetle were also in progress, mainly on the lines of using repellents to keep off the female beetles from ovipositing on the stems.

The extensive private collection now acquired by the Government of showy Indo-Chinese insects by Monsieur Vitalis de Salvaza, the result of several years' labour while he was still in the Treasury Department, is quite interesting but it is a mixed collection and a systematic study of crop pests may be said to be still in its infancy in Indo-China.

On the other hand, in Malaya, which includes the Straits Settlements and the Federated Malay States, Agricultural Entomology has made greater headway than in Indo-China of recent years. Work is at present confined to the insect pests of rubber, coconuts and paddy and it is evident there is a vast field for work for Entomologists in Malaya. The Entomological station is located at Kuala Lumpur, the Capital of Malaya, and is under the charge of the Government Entomologist, Mr. G. H. Corbett, B.Sc., with a staff of three Assistants, of whom one is Mr. D. Ponniah, for some time attached to the Entomological Section at Coimbatore.

The insects of Malaya, unlike those of Cochin-China, show a great affinity to the South Indian Fauna, and it often happens that pests, such as *Oxya velox* or *Leptocorisa varicornis*, have the same pest status as obtains in India but, on the other hand, certain Indian pests which

are also found in Malaya have been noticed to have developed different habits in the latter country. For instance, *Gangara thyrsis*, which feeds extensively on the coconut in South India and is popularly known as the coconut skipper, feeds rather exclusively on rattan (*Calamus rotang*) in Malaya. *Hidari ireva* is the Malayan coconut skipper. There are still other crop-pests which have a Malayan status but do not appear to have any corresponding status in India ; and others which, with the modern rapid means of transport, considering the time required to cross the Bay of Bengal is only three to four nights, may at any moment be landed in India with disastrous results to the country's Agriculture. unless a strict quarantine is maintained at all the Indian ports in reference to the import of plants, seeds, etc.

The following account of Malayan insects is arranged under crop-heads for easy reference. In this connection I have to state that I am deeply indebted to Mr. Corbett for the kind assistance he gave me during the few days I spent in his Laboratory, and for the information supplied by him on Malayan Insects, without which this paper could not have been written. My thanks are also due to Mr. Ponniah for similar help.

Pests of coconut and other palms.

Oryctes rhinoceros, Linn. The pest is under investigation at present in Kuala Lumpur. As in India, the chief breeding places of the beetle are village refuse and rotting palms.

The following details of the life cycle in Malaya are available :—

	Days.
Egg stage	11
Larva to cocooning	97
Cocooning to pupation	10
Pupa to adult condition	22
Adult to emergence from cocoon	9
TOTAL	149

Rhynchophorus schach, Oliv. It is now established that *R. schach* is specifically different from *ferrugineus* and Mr. Corbett popularly differentiates it as the "Red stripe weevil" whereas the Indian species is known as the "Red Weevil." The habits of these two species appear to be alike. *Rhynchophorus papuanus* appears to be a Far Eastern species but *ferrugineus* and *schach* seem to intermingle freely, except in South India where only *ferrugineus* is found. According to Leefmans, there is

a variety in Sumatra, Java and South Borneo combining the pronotum of *schach* and the elytra of *ferrugineus*.

The life-history of *R. schach*, Oliv., is being exhaustively studied in Malaya and there are several points which have been disclosed. A Bulletin on this weevil is in course of completion. The maximum number of eggs laid by a single reared female in captivity is 379. " The control measures consist in preventing injury to palms either by mechanical or other means and in reducing the number of Red stripe weevils by destroying dead palms." (Corbett.) There is a decidedly bad practice in Malaya of cutting broad steps on the stem of the coconut but Mr. Corbett is doubtful as to how far it is pernicious, since *Rhynchophorus* grubs, confined on the external layer of the coconut stems, are unable to cut through the hard interlying tissue and penetrate into the core or the pith of the palm.

Brachartona catoxantha, Hmpsn. (*Zygaenidæ*) is a sporadic major pest defoliating coconut trees and may be compared in South India with the ravages of *Contheyla rotunda*, Hmpsn. (*Limacodidae*). Pratt's bulletin on *Brachartona* (Bull. No. 4 Department of Agriculture, F.M.S., 1909) treats of the life-history and control measures.

Tirathaba sp. near *trichogramma* Meyr. is known as the greater coconut spike moth, infesting both open and unopen spathes. This pest has also been recorded from Fiji. A similar or allied species has been " found at Pusa whose larvæ bore into young coconut fruits in the bunch on the tree causing the young fruits to drop off " (*vide* Fletcher's *Annotated List of Indian Crop pests*, Bulletin No. 100, 1921).

Batrachedra arenosella, Walk. (*Cosmopterygidae*) is one of the recently discovered pests of the coconut and the details of its life-history are being worked out in Malaya. An interesting preliminary note by Mr. Corbett is published in the *Malayan Agricultural Journal* for May 1922. The insect is popularly known as the Lesser Coconut spike moth. The eggs are laid by the parent moth in the linear depressions of the green spathe and the larva bores into the unopened inflorescence and attacks female and male flowers alike. The damage done is considerable, a large percentage of female flowers being bored into. The full-fed caterpillar pupates in a slight cocoon of dull-white silk at the bottom of the spathe, the damage to which is apparent only when it opens. The bored ovaries begin to shed later on. Proper control is not yet devised. This moth enjoys a wide distribution and is recorded from Pusa, Calcutta and the Khasi hills in North India and Bangalore and Coorg in South India (*vide* Fletcher's *Lifehistories of Indian Microlepidoptera*, p. 104).

Plesispa reichei, Chap. (*Chrysomelidae*). This beetle is a pest of young coconut trees in Malaya. The damage done is caused by the beetles

and the straw-coloured grubs, feeding in the folds of tender leaflets, which are skeletonized. Decay sets in later on and the seedlings lose vigour and in a serious attack may collapse. Preventive measures, such as immersion of the seedlings in a solution of lead arsenate at ·25 per cent. strength with a week's interval, keep off the beetles from breeding on the treated seedlings. *Plesispa nipa* is another species defoliating wild sago palms.

Gangara thyrsis, Mo., is the cane skipper of Malaya and breeds more extensively on *Calamus rotang* than on the coconut palm.

Hidari ireca, Moore, is the Malayan coconut skipper. This insect prefers the coconut to other palms.

Amathusia phidippus, Johann. (*Nymphalidæ*) is apparently not an Indian species (fide Bingham) but exists in the Malayan Peninsula as a pest on African oil-palm leaves. The butterfly is a large-sized one with a wing expanse of 112-122 mm.

Catantops splendens, Thunb., has sometimes been found defoliating young coconut palms. Status not known. *Atractomorpha crenulata*, F., our common South Indian tobacco grass-hopper, appears to be a sporadic minor pest of coconut seedlings, attacking the leaves. An allied species, *A. psittacina*, De Haan, and *Tagasta marginella*, Thunbg. are also coconut defoliators of minor status.

Diocalandra frumenti, F., occurs in felled coconut trunks.

Pests of rubber.

Hemithea costipunctata, Moore. This Geometrid moth is recorded as damaging unopened rubber blossoms, eventually spoiling the whole shoot. The life-history has been worked out and is published with an illustration in the *Malayan Agricultural Journal* for April 1922 In the concluding paragraph of the publication the authors, Messrs. G. H. Corbett and D. Ponniah, state that at present this pest is of no serious importance, but if seeds are required commercially for the extraction of oil, further observations as to its habits and control will be necessary.

Coptotermes gestroi is primarily attracted to rubber estates due to want of clean clearing and the destruction of buried timber. Ant exterminators have been found useful.

Eurystylus sp. This Capsid bug sucks and spoils unopened rubber blossoms and is of minor importance.

Doloessa viridis, Linn. (*Pyralidæ*) is destructive to stored rubber seeds.

Omadius seticornis, Westw. (*Cleridæ*) breeds extensively in dead rubber trunks.

Pests of paddy.

Leptocorisa varicornis, Fb., in company with *L. acuta*, Thunbg., known as "*Pianggang*" in Malay, is a very serious pest especially to ripening paddy and obtains practically the same status as in India. Handnetting is in use.

Podops coarctata, Fabr., is a paddy pest of major importance in the Malay Peninsula. "The nymphs and adults suck the sap from the plant and when present in large numbers so weaken it that no grain is produced." (Corbett.) Flooding is advocated as control. The eggs of this bug are highly parasitized by a minute Chalcidid.

Diatraea auricilia, Dudg., is worse than *Schoenobius* (*Siga*) *punctellus* Wlk. (*bipunctifer*, Wlk.). The percentage of attack of both these borers varies considerably but is said to be about 20 and 10 respectively.

Chapra mathias, Fb., obtains the same status as in India.

Spodoptera pecten, Gn., in Malaya has the same sporadic major status on paddy as *S. mauritia*, Boisd., in India. *S. pecten* sometimes damages lawn and fodder grass heavily in the Malay States.

Nezara viridula, Linn., sucks paddy earheads but is kept in check by a black Reduviid bug, *Sycanus collaris*, Fb. (*leucomesus*, Wlk.), *Fauna of British India, Rhynchota*, Vol. II, page 352.

Tetroda histeroides, Fb., and a species of *Menida* exist in Malaya and with reference to paddy they have the same minor status as in India.

Oxya velox, F., and *O. vicina*, Bol., have been noted as destructive to paddy. Both are said to be minor pests.

Cyrtacanthacris succincta, Linn., and *C. luteicornis*, Serv., are found as pests of minor importance on paddy.

Nephotettix bipunctatus, Fb., *Melanitis ismene*, Cram., *Nymphula depunctalis*, Gn., are all pests in Malaya with which the paddy cultivator has to contend. All these have the same status as in India.

Some other pests of crops.

BANANA. *Erionota thrax*, Linn. The banana skipper is a serious pest of plantain leaves, defoliating entire trees. This skipper, although recorded from South India, does not appear to have any pest status here. The reddish eggs are laid in the evenings in groups of six to ten or less on the leaves and the larva cuts up the leaf and is enclosed inside a tubular cone and is protected by a mealy coating which keeps it from getting wet. The butterfly resembles *Gangara* in general build but is entirely different. The caterpillars are highly parasitized by *Chalcis marginata*.

CASTOR. *Achæa janata*, Linn. (*Ophiusa melicerta*, Drury) is a castor defoliator and has the same status as in India. The hymenopterous parasite, *Microplitis eusirus*, Lyle, is unknown in Malaya.

Notolophus (*Orgyia*) *postica*, Wlk. (*Lymantriadæ*) and *Tiracola plagiata*, Wlk. (*Noctuidæ*) are also castor defoliators.

CINCHONA. *Margaronia* (*Glyphodes*) *marginata*, Hmpsn., which also occurs in India, is a light green Pyralid moth noted in Malaya as a major leaf-rolling pest of Cinchona. It has been known to defoliate entire trees. This moth has been reared at Pusa on leaves of *Bombax malabaricum*, also from larvæ boring galls on leaves of *Alstonia scholaris* (Fletcher).

CITRUS. *Crocidomera robusta*, Moore (*Pyralidæ*) is a very serious pest of all kinds of citrus fruits. It is said that thirty to forty larvæ are not unusual in a single fruit with the result that the fruit affected drops to the ground and is unfit for any use.

COFFEE. *Cephonodes picus*, Cram. (*Sphingidæ*) is one of the commonest of day-flying clear-wing hawk-moths in coffee estates and has been noted to have attained serious proportions in certain years as a defoliator of Liberian coffee on which this moth breeds freely. In South India this moth commonly breeds on coffee on the Hills and on *Morinda tinctoria* in the Plains but has never been noted as a pest.

FRUIT TREES. *Podontia 14-punctata*, Linn., is a defoliator in orchards; the beetle is recorded as attacking fruit trees in Assam and Burma. (*Vide* page 169, *Annotated List of Indian crop pests* by Fletcher.)

HIBISCUS. *Acontia* (*Xanthodes*) *transversa*, Guen. The larvæ feed on the leaves of *H. esculentus*. Status minor. Occurs on the same food plant in India, Burma and Ceylon.

ROSE. *Arge victoria*, Kby. Larvæ on rose-buds and leaves. Another species of saw fly, presumably *Athalia proxima* Klug, is reported as attacking cultivated Cruciferæ extensively in Malaya.

SUGARCANE. *Phragmatœcia parvipunctus*, Hmpsn. is a borer of sugarcane and a very serious pest of this valuable crop. Life-history not known in detail.

Scirpophaga spp. also occur in sugarcane in Malaya but *Phragmatœcia* appears to be the more serious pest of the two. Other species of this genus exist in India and Ceylon, possibly the same species also, but their larvæ do not appear to have been noted as borers in sugarcane. A species of *Phragmatœcia* is described and figured in the *Report of the Proceedings of the third Entomological Meeting*, Vol. I, page 374, and is recorded as having been reared from wild Saccharum at Pusa.

4.—SOME PARASITES OF THE COTTON BOLLWORMS (*EARIAS INSULANA* AND *EARIAS FABIA*) IN THE PUNJAB.

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Introductory.

The first entomological work in connection with the cottons in the Punjab was done by Maxwell Lefroy in the year 1905, when the failure of this crop, through the ravages of the bollworms, caused a loss of rupees two to three crores to the *zamindars* of this Province. Since then certain statements, based more on theories than on experimental facts, have been put forward from time to time. Sometimes the parasites of the bollworms have been eulogised and at other times possibilities of this method of control rejected. With a view to discover the exact position, regular work on the pests of cottons and their parasites was started in 1918, and after preliminary studies of the pests, particularly *Earias spp.*, the study of the parasites of *Earias spp.* was taken in hand.

An account of the life-history of *Microbracon lefroyi* was communicated to the Entomological Conference held at Pusa in 1921. For the last two years we have been studying the parasites attacking the bollworms in the different stages of their life cycle (eggs, caterpillars and pupæ) and so far we have been able to record thirteen parasites on such stages of these serious pests of cottons. Most of these parasites have been very kindly identified for us by Waterston, to whom Dr. Guy Marshall of the Entomological Bureau sent our specimens. We express our indebtedness to the Entomological Bureau for the help we have been always receiving from them with great promptness.

It is to be regretted that it has not been possible to present a fuller account of the life-histories and bionomics of all the parasites of the bollworms mentioned in this paper. Besides, all our rearing experiments were conducted in a room where ants, lizards, and even mungooses and pigeons find free access, and where conditions in summer become so unbearably hot and dry that chances for insect life are reduced to the minimum, and parasites are delicate beings. We appreciate the value of a proper insectory more than we can express.

A regular survey of the important pests and parasites of cotton in the Punjab,* for the whole year has only been started recently and our present records are far from being complete, but we give them for what they are worth, fearing that restrictions on travelling may entirely remove all prospects of a complete work.

LIST OF PARASITES BRED OUT FROM VARIOUS STAGES OF *Earias insulana* AND *E. fabia* IN THE PUNJAB.

PARASITE ON EGGS :—	
Trichogramma evanescens, Westw.	Trichogrammatidæ.
PARASITES ON LARVÆ :—	
Bracon (*Microbracon*) *lefroyi*, D. & G.	Braconidæ.
Bracon (*Habrobracon*) ***kitcheneri***, D. & G.	Do.
Rhogas testaceus, Grav., var.	Do.
Elasmus sp.	Elasmidæ.
Actia ægyptia, Vill	Tachinidæ. (Diptera).
PARASITES ON PUPÆ :—	
Melcha nursei, Cam.	Ichneumonidæ.
Chelonus sp.	Braconidæ.
Chalcis tachardiæ. Cam.	Chalcididæ.
Chalcis responsator, Walk.	Do.
Chalcis sp.	Do.
Centrochalcis sp.	Do.

The above list includes the specimens identified by Waterston ; there is, besides these, an unidentified Ichneumonid bred from a bollworm caterpillar. The Tachinid fly was identified by Dr. Villeneuve.

PARASITE ON EGGS OF COTTON BOLLWORM.

Only one egg-parasite has so far been bred out from *Earias insulana* in the Punjab.

Trichogramma evanescens, Westw. (Trichogrammatidæ).

Trichogramma evanescens, Westw., *Philos. Mag.*, Vol. II, p. 444, ♂♀ f. 8, 9, (1833).

Calleptiles latipennis, Haliday, *Ent. Mag.*, Vol. I, p. 341, (1833).

* NOTE.—The facts of the geographical and seasonal distribution of these parasites given in the following pages are not complete in so far as our observations of the places outside Lyallpur are concerned. When we mention that a certain parasite has been observed during a certain time of the year at a certain locality, we do not mean that the parasite is absent from that locality during the rest of the year and is not found in the neighbouring locality. What we imply is that our observations were restricted to the particular part of the year only and to a particular locality.

Pteroptrix evanescens, Walker, *Mon. Chalcid*, Vol. I, p. 13, ♂, (1883).

* *T. evanescens*, Westw. *Qtrly. Jl. Micros. Sci., London*, (xii, no. 2, pp. 149-187).

Entomologiske Meddellser, Copenhagen, xii, no. 2, pp. 257-354 (1918); vol. xiii, no. 4, p. 183-188 (1920).

Hosts.—So far this parasite has only been bred from eggs of *Earias insulana* collected from hollyhocks. Parasites of this genus have also been bred from egg masses of *Euproctis lunata* at Lyallpur.

The *Earias insulana* moths lay eggs singly, usually a single egg being laid on each floral bud of a cotton plant. The eggs, being small and of the same colour as the leaf or flower bud, are not very visible and consequently difficult to collect in large numbers. We, however, found that large numbers of eggs are laid on hollyhocks during March, April and May, and collection of eggs was made from this plant. We cannot by any means call our collection of 300—400 eggs a large collection.

The eggs of *Earias insulana* when healthy are of a blue colour, but the parasitized eggs turn black, and can thus be easily distinguished. The adult parasite comes out of the egg by cutting a roundish hole on the side just below the crown. The egg-shell after the emergence of the parasite retains the black colour, unlike the egg shell from which a caterpillar has come out, which is always colourless.

So far as we have been able to find out this parasite has not been recorded from India from the eggs of *E. insulana*.

In England it has been bred from eggs of a Chrysomelid beetle, *Donacia simplex*, and has been recorded as parasitic on eggs of *Sialis*, *Stratiomyiads*, *Atherix*, *Chrysops*, *Tabanus*, and perhaps *Nonagria* in Europe. (*Review Applied Ent.*, vol. v, p. 451 and vol. vii. p. 231.)

Various other species of *Trichogramma* have been bred from various other hosts in Europe and America. In India Fletcher mentions an undescribed species of *Trichogramma* bred from *Chilo simplex* eggs. (*Proc. Ent. Conf.*, 1917, p. 182).

Distribution and time of occurrence.—We have bred this parasite only from the collection made at Lyallpur. In 1920 we bred *Trichogramma evanescens* for the first time in the Punjab from our collection of eggs made on 13th March from hollyhock, and the first parasite emerges on the 15th March. During 1921 we collected about 300 eggs from

'NOTE.—The facts of the geographical and seasonal distribution of these parasites given in the following pages are not complete in so far as our observations of the places outside Lyallpur are concerned. When we mention that a certain parasite has been observed during a certain time of the year at a certain locality, we do not mean that the parasite is absent from that locality during the rest of the year and is not found in the neighbouring locality. What we imply is that our observations were restricted to the particular part of the year only and to a particular locality.

hollyhocks, from February to April, but not a single parasite was obtained. In 1922, again, we resumed our collection of eggs from hollyhocks from the beginning of March and continued it till about the middle of May. From the collection of 370 eggs thus made we got parasites only from the March collection.

Date of collection.	Number of eggs collected.	Date of emergence of parasites.	Number of parasites emerged.
8th March 1922 . .	70	21st March	1
		26th March	1
25th March 1922 . .	15	3rd April	4

Life-history.—The following facts will throw some light on the length of the life-history of this parasite :—

(*a*) One of the female parasites that emerged on the 15th March 1920 was supplied with 26 fresh bollworm eggs collected from gardens. The parasite lived till 21st March, and 12 parasites emerged out of these eggs on 1st April, and one on 3rd April. Of the 26 eggs, caterpillars of *Earias* hatched out of only three. From the fact that the parasites are so rare it might be taken that all the eggs were parasitized in the laboratory. There remains, however, the remote possibility of previous parasitization.

(*b*) The unfertilized female Chalcidid that emerged on the 21st March was supplied with 11 eggs of *Earias insulana* laid by the moths in the insectary. The parasite died on the 23rd March and by the 3rd April, 4 parasites were found to have emerged and died. The adults were all males. The exact date of their emergence could not be ascertained.

PARASITES ON LARVÆ OF COTTON BOLLWORMS.

In the caterpillar stage the bollworms seem to fall victims to a comparatively larger number of parasites. These parasites are, most of them, external feeders, only two species feeding internally.

A. Among the external parasites are :—

1. *Bracon lefroyi*, D. & G.
2. *Bracon kitcheneri*, D. & G.
3. *Elasmus sp.*
4. An Ichneumonid (not yet identified).

B. The internal parasites are :—

5. *Rhogas testaceus*, Grav., var.
6. *Actia aegyptia*, Vill.

Bracon lefroyi, D. & G. (Braconidæ).

Rhogas lefroyi, D. & G., *Agri. Jour. Egypt*, Vol. III, pp. 109-110 (1913).

Microbracon lefroyi, D. & G., Brues, Proceed. Third Ento. Conf. Pusa, pp. 1026-1027 (1919).

Bracon lefroyi, D. & G. [name given by Waterston (1922)].

This parasite has been described by Dudgeon and Gough in the *Agricultural Journal of Egypt*, Vol. III, p. 109. We have compared this description with our specimens named by Waterston.

This parasite is familiar to the workers of this country as it has been recommended ever since 1905 for checking the increase of bollworm caterpillars in the cotton fields. We, in the Punjab, have been usually importing the cocoons of these parasites from Pusa for establishing it in our fields early in the cotton season. Attempts were also made to introduce this parasite in Egypt, and living specimens were imported, but the parasite could not be established there successfully. (*Agricultural Journal, Egypt*, Vol. III, p. 109).

Hosts.—We have so far bred this parasite from *Earias insulana* caterpillars only, no other host being yet observed. Specimens of *Bracon spp.*, not yet identified, have been bred from caterpillars of *Vanessa cardui*, *Leucinodes orbonalis*, *Nephopteryx sp.*, and a caterpillar feeding on cabbage leaves in May. One species has also been bred from *Acacia* pods attacked by beetles, *Bruchus vectabilis*, *Amblyrrhinus poricollis*, and *Caryoborus gonagra*. Adult specimens of some of these parasites have also been collected from a *Citrus* hedge and from mulberry trees infested with Jassids.

We have bred *Bracon lefroyi* from bollworms feeding in cottons and *bhindi* pods and also on hollyhocks.

Distribution and time of appearance. The various localities visited during the different times of the year show that this parasite is present in nearly all the cotton-growing regions of the Punjab, though not in any large numbers. The following localities have been visited during the last five years and grubs of *Bracon lefroyi* collected from the cotton fields.

Hansi, July and August 1919, January, September, November and December, 1920, August 1921, January 1922; Palwal (Gurgaon District), August and December 1921; Rohtak, October 1919, July 1920; Bhatinda, October 1919; Ferozepur, September 1919, September 1922; Montogomery, November, December 1919 and 1920, August 1921, September 1922; Lyallpur, generally present from September to December and also in March and April on bollworms on hollyhocks; Lahore

October and November 1921 ; Jullundur, September, October, 1920 ; Sialkot, October 1921 ; Sargodha, September 1921 ; Jhelum, September 1921. (A large number of grubs was collected from flower buds that had dropped down the plants after a shower of rain. Percentage of parasitization of bollworm was 9 in case of the crop and 20·9 in case of fallen buds.)

No pronouncement can be made regarding the efficacy of this parasite in controlling the bollworms of cottons.

It is rather unfortunate that our knowledge of this important parasite in the Punjab is so incomplete. For want of staff we have not been able to institute a complete survey of this parasite but we hope to take it up in the coming cotton season.

Life-history.—A paper giving the details of life-history and bionomics of this parasite was read at the last Entomological Meeting ; the following summary may, however, be useful. Eggs are laid on the body of the caterpillar after it has been stung and paralysed. Generally, full-grown caterpillars are selected for oviposition, though in the laboratory eggs have been laid on the caterpillar that had spun a cocoon. Each egg is elongated, with rounded ends, measuring 1 mm. in length. It is translucent when fresh, but the ends become hyaline, as it undergoes development and the final colour is yellowish. Eggs may be laid singly or in groups of two to six. The number of eggs laid on a single caterpillar in the laboratory varies from one to nineteen. The highest number of eggs laid in captivity by one female has been 219 (the female was not fertilized).

The egg hatches out in 21 to 23 hours during July and August ; and in 24 to 26 hours in October.

The freshly-hatched grub is active and begins to suck the juices from the body of the host ; it is creamy-white in colour. The head is very large as compared to the body, which tapers posteriorly. Generally the grub remains fixed to the spot where it starts sucking till it is fullfed. The full-grown grub measures about 2·5 mm. in length and is 0·75 mm. thick. It is more or less spindle-shaped, being thickest in the middle. The body segments are distinct, and the body-wall is transparent and thin so that the tracheæ and fat-cells are seen through it. The grub stage lasts for 32 to 37 hours in August, 67 hours. in October, 4 to 5 days in November, and over 10 days in December, under laboratory conditions.

When full-grown, the grub leaves the host and begins to spin a white silken cocoon, measuring about 3 to 3·5 mm. in length and 2 mm. in breadth. Soon after completing the cocoon the grub passes out black excretion and turns into a pupa after some time. The eyes appear as

shining red-brown spots, antennae are curved down and reach the fifth abdominal segment. The pupa is at first of a yellowish white colour, but undergoes change as it develops. The pupa measures 2 to 3 mm. long and 1 mm. thick. Duration of the pupal stage is 4 to 7 days in September-October : 18 to 22 days in December ; and 27 days in January. The adult parasite comes out of the cocoon by cutting a circular hole in one end.

The duration of the various stages of life cycle of *Bracon lefroyi* is much prolonged in winter, as is the life of the adult parasites. We have not been successful in making the female parasites that emerge in December and January, to lay eggs or attack the bollworm caterpillars in the laboratory. Some parasites were kept in the incubater at 23°C. but no eggs were laid by them.

2. *Bracon kitcheneri*. D. & G. (Braconidæ).

Rhogas kitcheneri. D. & G., *Agri. Journal, Egypt*, Vol. III, p. 108 (1913).

Habrobracon kitcheneri. D. & G., *Sultanic Agric., Soc., Cairo*. 1916, p. 339, 10 plates, 17 figs. by F. C. Willcocks.

Bracon kitcheneri. D. & G. [Name given by Waterston to our specimens (1922)].

The specimens bred by us in the Punjab have been named by Uvarov and Waterston, and compared with the description of the Egyptian species.

Hosts.—This is not a common parasite of *Earias spp.* in the Punjab, and we have bred it only once from these caterpillars. Here it is a common parasite of *Phycita infusella* and *Nephopteryx* sp. larvæ. In the laboratory we supplied a female parasite with caterpillars of *Earias insulana*, *Chilo simplex*, and *Plusia* sp. : she laid eggs on each of these caterpillars, the grubs lived on the juices of the caterpillars and adult parasites were bred out of these grubs.

Distribution and time of occurrence, so far recorded :—

Locality.	Time.	Host.
Lyallpur	June, July, November	*Phycita infusella.*
Rohtak	July	Do.
Montgomery	July and August	Do.
Lyallpur	July	*Earias insulana.*
Do.	January and March	*Nephopteryx sp.*

Life-history.—Eggs are laid on the body of the host in clusters of three to five or sometimes singly. Each egg is elongated, measuring 1 mm. in length. The egg stage takes from four to six days in January, about two days in February and one day in August.

The grub, when freshly hatched, is whitish. When full-grown it is spindle-shaped with transparent body wall through which fat cells and the contents of the body are seen. The grub stage occupies as many as twelve to eighteen days in December-January, five to six days in February and three days in August.

When fullfed the grub spins a white silken cocoon around itself and pupates therein. The pupal stage takes 16 to 19 days in December and February (the prepupal stage taking in addition as much as 5 days), and 3 to 4 days in August. The adult parasite comes out by cutting a round hole in the cocoon.

The female parasite can lay eggs without being fertilized but progeny in such cases consists of males only.

In Egypt *Bracon kitcheneri* is parasitic on the Cotton bollworm (*Earias insulana*), and the Date worm (*Ephestia cautella*) and is widely distributed. Dudgeon mentions in the *Agricultural Journal of Egypt*, III, pt. 2, pp. 108—109, as follows :—

"In common with other Braconidæ this insect deposits its eggs in the larvæ of the host insect. The larvæ of the parasite emerge from the host larva and pupate outside in small ovoid silken cocoons, generally found associated with the dead larva of the host." But, here in the Punjab, our observations differ on this parasite. We have bred this not only from *Earias insulana*, but also from *Phycita infusella* and *Nephopteryx* sp. larvæ, and other caterpillars and in all these cases it has been observed feeding *on* the body of the host caterpillars and not *in* it.

Bracon kitcheneri has also been bred from Pink bollworms in captivity in Egypt (*Sultanic Agri. Soc. Cairo*, 1916). Fletcher and Misra have mentioned the alternative hosts of *Microbracon* spp. and give the Pink Bollworm and *Phycita infusella* amongst the hosts (*Proceed. Third Entom. Meeting*, p. 453). There is a possibility of this species being allied to *Bracon kitcheneri*.

3. *Elasmus* sp. (Chalcidoidea : Family Elasmidæ).

Genus *Elasmus*. Westwood, *Philos. Mag.*, Vol. III. p. 343 (1833)
Aneure. Nees, *Hym. Ichneum. Affin.* Mon., Vol. II. p. 194 (1834).

Two species of these parasites have been bred out in the Laboratory. One species has been reared from a deserted nest of a common yellow wasp * attacked by the caterpillars of *Hypsopygia mauritialis* ; the other species was got from *Earias insulana*, and we will give the details of this latter species.

* Probably *Polistes hebraeus*.—Editor.

Description of the adult :—

Head black, broader than long, but as broad as the thorax. Eyes bluish-black, shining. Antennæ blackish, scape very long as compared with the other joints of the flagellum. Flagellum 5-jointed, the first joint longer than the rest, the rest of the joints nearly equal; the last longer and divided into three parts, thickest at the base and tapering towards the apex. In males the antennæ are much divided, long thick hairs arising out of the flagellum. Flagellum 8-jointed, and hairs arise from the 2nd, 3rd and 4th joints of the flagellum. Pronotum shining black dorsally. Meso- and metanotum dull black. Wings clear. Legs black with brown tibia and tarsal joints. Femur dilated in the 2nd and 3rd pairs of legs. Abdominal segments shining black. Ovipositor black. Total length of male, 1·5 mm., forewing 1 mm.; total length of female, 2 mm.

Host.—This species has been bred from grubs on the caterpillar of *Earias insulana* and in some cases from the cocoons of this species that were collected from the fields. In the laboratory it was reared on caterpillars of *Earias insulana*. It has also been observed attacking the larvæ of *Platyedra gossypiella* in the laboratory, though we have not so far obtained it from the fields on this host.

Distribution and time of appearance.—The grubs of this parasite are met with on the caterpillars of cotton bollworms about the same time as the grubs of *Bracon lefroyi* in the cotton fields at Lyallpur. We have collected these grubs from the following localities :—Lyallpur, January, April, June, November, and December 1920 and February 1921; Sargodha, June 1920; Rohtak, October 1919; Hansi, August, November, December 1919, June 1920.

Life-history. The female parasite is capable of laying eggs without the help of a male, but in such cases the progeny consists of males only. The parasite paralyses the host before oviposition and, being of very small size as compared to the host, executes this rather smartly. Eggs are laid on the body of the host in a line touching one another. Each egg is about 0·5 mm. long and is translucent white in colour. As many as ten eggs have been laid on a single caterpillar in captivity, while from bollworms collected from fields as many as eighteen adult parasites have been bred out from one host. Duration of the egg stage is about 24 hours in October.

The freshly-hatched grub is slightly over 0·5 mm. in length. It sucks the juices from the body of the host until full-grown. The grub stage lasts about three to five days in October and thirteen to fourteen days in December. When full-fed the grub pupates openly near the remains of the host. The pupa is dirty-white when fresh but turns

yellowish-grey later on. After a few days it becomes brown in colour, and later on blackish colour appears. The pupal stage lasts for about three days in June, five days in October, and 26 to 42 days in December.

The male pupa measures 1·5 mm. × ·5 mm.

The female pupa measures 2·5 mm. × ·5 mm.

4. An unidentified Ichneumonid.

This specimen has been sent to Dr. Marshall of the Imperial Bureau of Entomology for identification but has not so far been received back.

Description of adult.—Head black, shining, with long black antennæ. Pronotum black, mesonotum brown, metanotum black dorsally and laterally. Legs slender and long. First two pairs yellow, the trochanter and femur of the 3rd pair brown. Abdominal segments black, narrow and much longer than the wings. Total length 7 mm.

Host.—This parasite has only once been bred from a flowerbud of cotton probably attacked by an *Earias insulana* caterpillar. The grub was got from inside the cotton seed, and the remains of the host were not very distinct. Similar parasites have also been bred from larvæ of *Eucosma plebeiana* feeding on hollyhock flowerbuds.

Distribution.—The grubs were collected from cotton buds at Lyallpur in January 1918, and the parasite from hollyhock was bred in March 1921.

Life-history.—Earlier stages of this parasite could not be studied as the grub soon began to spin its cocoon. The cocoon is silken white and the pupa is seen inside it. The pupa measures about 5 mm. long and is of yellowish colour with brown eyes. Later on a black mid-dorsal stripe appears on abdominal segments.

INTERNAL PARASITES.

5. *Rhogas testaceus*, Grav., var (Braconidæ, sub-family Rhogadinæ).

The " Yellow Braconid " has been said to be a variety of the common European species *Rhogas testaceus*, and Waterston has given our specimens the name *Rhogas testaceus*, Grav. var.

Rhogas testaceus, Spinola, Ins. Lig., Vol. II, p. 131 (1808).
ochraceus, Curtis, Brit. Ent., Vol. XI, p. 512 (1834).
sabicola, Curtis, Brit. Ent., Vol. XI, p. 512 (1834).
similis, Curtis, Brit. Ent., Vol. XI, p. 512 (1834).
spathuliformis, Curtis, Brit. Ent., Vol. XI, p. 512 (1834).

Description of the adult.—Head yellowish-brown with black eyes; 3 ocelli on a dark spot. Mandibles blackish. Rest of the head with antennæ, yellowish brown. Flagellum 31-32 jointed. Scape deep

yellow, longer than any of the joints on the flagellum. First joint of flagellum shorter and thicker than the rest. The joints gradually getting smaller in size apically. Thoracic segments brownish. Legs yellowish-brown with dark brown tarsal ends. Abdomen linear and of yellowish-brown or dark brown colour dorsally, and yellowish-brown ventrally. Total length in males 4 mm., in females 5 mm. Forewing 4·5 mm. Ovipositor 1 mm.

Hosts.—We have bred this parasite only from young caterpillars of cotton bollworms. The female parasite was supplied with a caterpillar of *Platyedra gossypiella* in the laboratory, but it was not parasitized.

From a large collection of bollworm caterpillars made from fields and which later on appeared to be parasitized and in which the pupa of the parasite developed, it was observed that the parasitic grubs turn to pupæ when the host is in the third instar. Bollworm caterpillars in the fourth instar have only rarely harboured the parasite. In the laboratory, bollworm caterpillars in different stages of their growth were supplied to the female parasites to find out the stage prefered for oviposition. Although nearly full-grown caterpillars have also been attacked in the laboratory yet caterpillars in the third stage have been preferred. Younger caterpillars have been attacked but pupæ of the parasite never developed in them.

Stinging.—The stinging process in the case of this parasite may last for as long as $3\frac{1}{2}$ minutes, but is never continuous. It has been observed that a caterpillar stung eight times leads a normal life, pupates and comes out as a moth in due course of time. Unless the host is stung and oviposited upon, the caterpillar revives soon after the parasite leaves it. After oviposition, however, the host feels very uneasy and lies motionless for about ten to seventeen minutes, after which it revives and begins to feed and grow.

Distribution and time of appearance.—This parasite is of very common occurrence, and is widely distributed throughout the cotton-growing regions of the Punjab. It is generally present in the fields from August till December. At Lyallpur we find it till about March and April on hollyhocks, but it is very common in November and December, and adults go on emerging in the laboratory till February. At Sargodha we observed it in September 1918, in Jhelum during March 1920, at Sialkot, November and December 1921, at Lahore, October 1921, at Bhatinda, November 1919, at Rohtak, October 1919, and at Hansi, October 1920, August 1921, and January to March 1922. It is very likely that this parasite is present throughout the year.

Life-history.—The parasite is an internal feeder and all of its earlier stages are passed inside the body of the host. Only the adult parasite

comes out of the body of the parasitized caterpillar, which can only be distinguished from the healthy caterpillar by the characteristic appearance of the host when the entire contents of the body are eaten up. At this time the parasitic grub is fullgrown and about to pupate. The study of the earlier stages of this parasite could not be taken up due to lack of time and material. The full-grown grubs are white and thick in structure, and occupy the whole of the body of the host, being enclosed in the outer chitinous covering, which turns red-brown. The head segment of the host is fixed by a sort of gum secreted out as the worm is killed, and forms a sort of neck with the rest of the body, which is swollen up.

Description of pupa dissected out of the host.—The pupa measures 4 mm. by 1 mm. The head is pale yellow, mandibles brown tipped. Ocelli raised, pale yellow, having red-brown area separating one another. Eyes dull black. Antennae pale yellow, reaching up to the end of the body. Thoracic region yellow. Legs pale yellow. Abdomen yellow. The pupal stage, counting from the day the host turns red-brown, lasts for 16 to 25 days in November, 25 to 31 days in December, 26 to 27 days in January, 13 to 17 days in February, and 10 to 11 days in March. The adult comes out of the pupa by cutting a circular hole at the posterior end of the host dorsally. The female starts the work of laying eggs from the very day it comes out. Virgin females give rise to males only, while we get both males and females from a fertilized female.

The duration of life-cycle is different in male and female parasites. The life-cycle of a male parasite occupies about 13 days in October, 26 to 34 days in November, and about 37 days in January. In the case of a female parasite the period is more prolonged, taking about 15 days in October, about 41 days in November, 40 to 51 days in December, 51 days in January, and 23 to 36 days in February.

6. *Actia ægyptia*, Vill. (Family Tachinidæ). [Diptera.]

Gymnoparia ægyptia, Vill.

This is the only Tachinid that has been bred out as a parasite of *Earias insulana*. The adult parasite is figured on plate XI opposite page 68 in the *Proceed. Fourth Entom. Meeting*. 1921.

Hosts.—These flies have been bred out from *Earias insulana* and *Laphygma exigua* caterpillars in the Punjab. From Southern India it has also been recorded as parasitic on *Spodoptera mauritia*, (*Proc., Fourth Ent. Meeting*, 1921, p. 67).

Distribution and time of occurrence.—This fly has been bred from *Earias insulana* caterpillars collected from the following localities.—

Lyallpur, October to January on cotton and April and May on holly hock; Lahore, October; Sialkot, October; Jullundur, January; Hansi, January and April; and Bhatinda, October. It has also been obtained from *Laphygma exigua* caterpillars feeding on lucerne at Mona (in Sargodha) during August and September.

Life-history.—Our attempts to breed this parasite in captivity have not been successful, and thus the earlier stages could not be studied. It is an internal parasite, the maggots feeding inside the body of the caterpillar and both the host and the maggot going on feeding, so that the caterpillar does not show any sign of attack as long as the maggots are inside the body of the host. The host dies when the maggots come out for pupation; generally, the host at this stage is a full-grown caterpillar. The maggot, when it comes out of the body of the host, is about 5 mm. long and 1·5 mm. thick. It is yellowish white in colour and is thickest at the posterior end and pointed anteriorly. The mouth parts are fine, black, hook-like structures. It soon turns yellow and then brown in colour. The pupa measures 4 mm. × 1·5 mm. The pupal stage lasts for 7 to 9 days in April and May, while it takes as many as 21 to 28 days in November and January. One host generally contains one or two maggots.

Parasites on Pupae of *Earias insulana*.

Another half-a-dozen parasites have been bred out from cocoons of *Earias insulana.* The list given below includes as many as six parasites, but none of them exists in numbers that may be said to be an efficient check upon the increase of the bollworms :—

1. *Melcha nursei*, Cam.	Ichneumonidæ.
2. *Chelonus* sp.	Braconidæ.
3. *Chalcis tachardiæ*, Cam.	Chalcididæ.
4. *Chalcis responsator*, Wik.	,,
5. *Chalcis* sp.	,,
6. *Centrochalcis* sp.	,,

1. *Melcha nursei*, Cam.

These parasites have been bred from cocoons of *Earias insulana*, collected from the cotton fields. The parasite in captivity generally attacks bollworm pupae inside the cocoons. Caterpillars that have started spinning but have not pupated may also be attacked. A full-grown caterpillar was kept confined with a female parasite for about six days, but it was stung only when it had started spinning. The parsite has also been observed stinging empty cocoons of *Earias* when the caterpillar had left it, after it was stung in the cocoon.

Distribution and time of appearance.—These big parasites are seen flying about in the fields of cotton, lucerne, *Senji* and in the gardens on hollyhocks. It has been noted at Lyallpur, November to March in fields and March and May on hollyhocks; at Hansi, from cocoons collected in December 1918 and July and October 1920; at Lahore, October 1921; at Jullundur, in August and October 1920; at Sargodha, October 1920.

Stinging.—The process of stinging is a very long one in the case of this parasite. The female has been found to be stinging the cocoon for as long as 67 minutes continuously. It has been observed that, while stinging, the ovipositor is thrust inside the fibres of the cocoon, and may not be actually touching the body of the pupa for a considerable length of time, as long as 19 minutes in one particular case.

Life-history.—Eggs are laid inside the cocoon on the body of the host in captivity; in one case they were deposited on the glass dish near the full-grown caterpillar, which was stung. Each egg is whitish, slightly curved, measuring about 1·5 mm. in length and 0·5 mm. in thickness. The exact number of eggs laid by one female parasite is not yet known. Three parasites bred in the laboratory laid 9, 4, and 11 eggs in October, December and February respectively. Generally one or two eggs are laid on a pupa, but in captivity as many as 7 eggs were laid on a single pupa. All of these eggs hatched out, but only one grub reached maturity. The egg stage lasts for a day only during October, while it takes 5 to 6 days during December to March, the ends becoming hyaline after about 3 days.

A freshly-hatched grub is very active, it is white in colour and has a thick head, the body tapering towards the hind end. The head is yellowish brown, and the body segments well marked. As it grows, the head becomes pointed and hyaline. The body wall is transparent and the greenish contents of the intestine are seen through it. When fullfed the grub is about 10 mm. in length. In January the grub stage occupies about 12 days, but the stage between the full-grown grub and its pupation takes as many as 18 days.

The pupal stage is also passed inside the cocoon of the host, although cases have occurred in the Laboratory when the grub came out of the cocoon of the host and spun a light silken white cocoon in the dish or on the leaf. In one case it pupated openly. The pupa when fresh is white with brown eyes. Later on, the colour becomes dirty white, and the eye spots grow darker. A few days after this the thorax becomes orange in colour and black spots appear on the abdominal region and legs. The pupa undergoes a considerable change later on and may be described as follows:—Front lamp-black with pale yellow outline. Scape white. Mouth parts sepia. Thorax orange vermilion. Legs white.

Abdomen white with black bands at the intersegmental region, laterally white. Ovipositor black.

The pupal stage lasts for about 7 days during August, while it takes as many as 20 days in February. The adult parasite comes out of the cocoon by cutting an irregular hole laterally towards the posterior end of the cocoon of the host.

It may be noted with interest that in nature this parasite does not appear to be an external feeder. Specimens of nearly fullgrown caterpillars have been collected from fields without any signs of having been parasitized. They had started spinning cocoons in many cases and in some cases had actually spun their cocoons, but instead of getting a bollworm moth, we got out the parasite. This point requires further observations. What seems likely is that the grub feeds inside the body of the bollworm caterpillar, and both the parasite and the host grow side by side. When the grub is full-fed it comes out of the body of the host and spins outside the remains of the host, but inside its cocoon.

The following table shows the duration of the life-cycle of this parasite, during different times of the year.

Date of oviposition.	Adult emerged.	Duration of life cycle.	Sex of adult.
		Days.	
17th-18th August	30th August	13	♂
12th-13th October	26th October	14	♂
1st January	24th February	54	♂
3rd February	9th March	34	♂
19th February	17th March	26	♂
7th-15th February	21st March	34—42	♂
1st March	21st March	20	♂

The adult parasite also lives for a considerably long time. The adults caught in October and December in the fields lived for about 9 days only, but the adults caught in January and February lived for from 18 to 36 days.

This parasite is the commonest of the parasites on pupae of the bollworms, and may be effective in reducing the number of the bollworms, as it is present in August and September when the bollworm attack on cotton starts. Although the exact number of eggs laid by one female is not known, it can be said with certainty that the parasite kills a number of cocoons without ovipositing on them, as, out of a large

number of cocoons supplied to the parasite, the eggs were deposited only on a few, while all of them were stung and killed.

2. *Chelonus* sp. (Family Braconidæ, Sub-family Cheloninæ).

Genus *Chelonus*, Jurine, in Panzer, *Krit. Revis.*, Vol. II, p. 99 (1806).

Chelonus, Trans. Ent. Soc. Lond., 1885, p. 113.

Trachionus Haliday, *Ento Mag.*, Vol. I, p. 265 (1833).

Description of the adult parasite.—The specimens bred from *Earias insulana* have been retained by Waterston; the following description is of the parasites bred from other hosts in our collection. Head dull black. Eyes black, shining. Clypeus shining black. Ocelli raised, shining black. Thorax black both dorsally and laterally. Wings, lower half clear, apical half brownish. Stigma light brown. Tibia yellowish, rest of the legs with the tarsal joints black. Abdominal segments not distinct. Basal half abdominal region brown with dark mid-dorsal longitudinal stripe, the apical half sepia. Total length 4 to 4·5 mm. Forewing 3 mm.

Hosts.—*Earias insulana* cocoons when kept for breeding out the moths gave us this parasite. It is not a common parasite of cotton moths and has a variety of other hosts (two of which happen to be pests of cotton plants). We have bred it from caterpillars of *Laphygma exigua*, *Tarache* sp., and pupae of *Phycita infusella*. The Lyallpur collection also contain parasitic adults labelled as being bred from larvæ on maize, jute and brinjal.

Distribution and time of appearance.—This parasite has been bred at Lyallpur from cocoons of *Earias insulana* in June; from pupae of *Phycita infusella*, in July; on maize and brinjal in May; and on jute in July. From Hansi it was got from larvæ of *Tarache* sp. in July. From Mona, in Sargodha, this parasite was bred out from the collection of *Laphygma exigua*. A species of this genus has also been recorded as being parasitic on *Spodoptera mauritia* in Southern India. (*Proc. Forth Entom. Meeting*, Pusa, 1921, p. 68).

Life-history.—This parasite is not of common occurrence and only two or three adults have so far been bred out from the large collection of bollworms, etc. Its different stages in the life-history have not yet been studied. The adult parasite comes out of the cocoon of the host by cutting a circular disc at the anterior end. This disc is left attached to the cocoon of the bollworm caterpillar on one side and is pushed by

the adult parasite like a door. In the case of *Tarache* sp. the adult parasite comes out by cutting a hole on the dorsal region of the caterpillar.

3. *Chalcis tachardiæ*, Cam. (Family Chalcididæ).

This parasite is the commonest of the Chalcidid parasites bred from *Earias* cocoons.

Host.—So far, it has been bred only from cocoons of *Earias insulana* in the Punjab. In Dehra Dun it has been recorded on the following hosts :—*Hypsipyla robusta*, *Pupa* (*Indian Forest Records*, IX, pp. 1—iv) ; on *Eublemma amabilis* or *Hypatima pulverea* on *Tachardia lacca*, Kerr. (*Indian Forest Mem. Forest Zool. Ser.* III, No. 1, 1915).

Distribution and time of occurrence.—It has been collected from Hansi in August ; and Lyallpur from September to December. Adult parasites have been collected from fields in February and June also at Lyallpur.

Life-history.—The grubs and pupae of this parasite remain in the cocoon of the host. The adult fly comes out by cutting a clear circular hole at the anterior end of the cocoon of the host. In the laboratory full-grown caterpillars collected from fields were supplied to the parasites on 13th August. The parasite was dead on the 17th and adult parasites emerged out on 25th and 27th August. The duration of life-cycle may therefore be from 8 to 14 days approximately.

4. *Chalcis responsator*, Wlk. (Family Chalcididæ).

This specimen has been retained by the British Museum. The adult parasite resembles the adult of *Chalcis tachardiæ* in general form excepting that the wings in this case are banded and not clear. It is described in the *Trans. Entom. Soc., Lond.*, pt. 4, p. 355 (1862).

This parasite was obtained from a collection of cocoons made from Hansi in July.

5. *Chalcis* sp.

This species was bred from cocoons of *Earias insulana* collected from Lyallpur in July. We bred this parasite only once and have not come across it again.

6. *Centrochalcis* sp.

These parasites have also been kept by Waterston for identification. This species was bred from a collection of *Earias insulana* cocoons made

at Lyallpur during July. We had only two specimens of this parasite bred out one year, and could not get any more of them.

The work of finding out the percentages of bollworm attack and of parasitization was started in the year 1921-22, but unfortunately it could not be worked out throughout the season. The following data were, however, collected.

Month of observation.	Districts visited.	AVERAGE PERCENTAGE OF		Parasites bred.
		Bollworm attack.	Parasiti-zation.	
1921—				
August	Hissar	3·2	50·0	Nos. 1 and 2.
Do.	Gurgaon	2·4	33·3	Nos. 1 and 2.
Do.	Montgomery	6·8	14·5	No. 1.
September	Lahore	7·7	16·6	Nos. 1, 2 and 3.
Do.	Sargodha	6·1	2·4	Nos. 1, 4.
Do.	Sargodha (fallen buds).	93·1	6·6	Nos. 1, 4.
Do.	Jhelum	7·4	9·0	No. 1.
Do.	Jhelum (fallen buds)	78·4	20·9	No. 1.
October	Lahore	8·6	21·5	Nos. 1, 2, 3.
Do.	Sialkot	6·7	8·2	Nos. 1, 2, 3.
December	Gurgaon	14·9	25·0	No. 1.
1922—				
January	Hissar	45·5	17·0	Nos. 1, 2.

No. 1.—*Bracon lefroyi*, D. & G.
No. 2.—*Rhogas testaceus*, Grav, var.
No. 3.—*Actia ægyptia*, Vill.
No. 4.—*Melcha nursei*, Cam.

Conclusions.—So far we have observed 13 parasites on the various stages of *Earias insulana*, but it does not seem that this unlucky number is of any great help to us in fighting this pest. The highest figures of parasitization obtained have been 50 per cent for Hissar in August 1922, and one would have thought that the number of parasites would increase with greater rapidity than the numbers of the pests, yet in the same place in January 1922, the percentage of parasitization was only 17 whereas the pests increased to 45·5 per cent.

As far as our observations go, we are not able to say that the parasites keep the pests in check or that they provide a workable method of control.

Table showing the actual number of Bollworm moths and their Parasites bred out in the Punjab Agricultural College laboratory.

YEAR AND MONTHS OF COLLECTION.	1918.					1919.					1920.					1921.					1922.				
Names of the adults bred out.	August.	September.	October.	November.	December.	August.	September.	October.	November.	December.	August.	September.	October.	November.	December.	August.	September.	October.	November.	December.	August.	September.	October.	November.	December.
Earias insulana	220	18	32	1	..	90	..	..	386	8	435	147	222	60	436	57	134	128	374	16	72	334	212	8	45
Earias fabia	..	2	3	..	..	22	..	..	..	..	..	11	..	..	..	2	..	..	..	..	..	..	1	..	..
Earias cupreoviridis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	1	..	..	..	..	..	..	..
Platyedra gossypiella	2	..	..	..	..	1	..	14	..	..	4	10	1	..	1	4	..	4	..	7	1	..	1	..	..
Bracon spp. (mainly *B. lefroyi*)	..	..	25	..	..	2	..	..	76	17	3	87	..	..	7	1	57	46	47	2	3	..	5	3	..
Elasmus sp.	..	..	1	1	..	..	..	..	21	51	..	2	47	7	..	..	..	..	..	..	..	19	2	..	..
Rhogas testaceus, Grav., var.	3	..	8	1	..	3	..	..	36	1	1	1	13	12	40	3	..	19	1	2	2	1	70	5	1
Actia aegyptia, Vill.	1	..	..	..	..	..	..	..	48	3	2	..	3	3	12	..	..	2	7	1	..	1	4	1	..
Chalcis tachardiae	1	..	..	..	..	..	..	..	..	..	8	1	1	1	..	..	..	..	..	..	1	2	..	..	..
Chalcis responsator	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Melcha nursei	..	..	..	..	..	..	..	..	..	..	2	1	3	..	1	..	3	..	..	..	..	1	..	..	..

5.—COLOUR VARIATIONS IN *EARIAS INSULANA*, BOISD., IN THE PUNJAB.

By UMRAO BAHADUR MATHUR, L.AG., *Agricultural Assistant, Punjab Agricultural College, Lyallpur.*

A study of colour variations in moths is of great importance to Economic Entomologists, as, in devising remedial measures, they must definitely know the species they are dealing with. Habits, life-histories, etc., of closely-allied species often differ markedly. In this particular instance of the cotton-bollworm, we find that the various colorations and markings have been, as pointed out by Storey (*Agri. Journ., Egypt*, III, 99), the cause of this one species being described under no less than nine distinct names as follows—*insulana*, Boisd., *smaragdinana*, Zell., *siliquana*. H. Sch., *frondosana*, Walk., *simillima*, Walk., *chlorion*, Rmb., *gossypii*. Frauenf., *tristrigosa*, Butl., and *xanthophila*, Butl.

Storey worked in Egypt in 1913 and published a note on " Seasonal variation in *Earias insulana*, Boisd.," in *Agri. Journ. Egypt*, 1913. He also gives a plate (No. 6) showing 16 different forms of moths got in Egypt from September to December 1912. His figures numbers 15 and 16 come near to the Punjab form of *Earias insulana*. We, in the Punjab, do not get all these forms, illustrated by him. Varieties of moths shown in his figures 1—6 are entirely absent from the Punjab, while we commonly get moths figured by him on the plate under Nos. 7 to 14 during winter, the pure green form (fig. 15—16) being the only form present from May to about October. From about the beginning of November we get all sorts of moths mixed together. The summer form is absent during these months.

We agree with Storey when he says that these various forms run imperceptibly into one another, and overlap to a very large extent. We have been getting moths resembling one another in general coloration but with slight modifications—in the depth of the costal marginal colour band or posterior marginal band; in the presence and prominence of dark lines across the wings or in their being absent or being very faint lines, etc. In addition to the illustrated forms mentioned in Storey's plate (figs. 7 to 14) we have in the Punjab moths with pale green, different shades of brown and mixtures of brown and green and yellow colours on their forewings. We also find a white, yellow, grey or pink band on the dorsal margin of the wing and sometimes on both the margins as in Storey's fig. 13.

However, our observations in the Punjab differ from those of Storey in Egypt, in that his December collection contained mainly the yellow

variety; there in December the green moths with pale margin to the wings were very rare, but they were most common in November. Thus he has been able to say that a particular form is present at one time of the year and the other form is prominent at the other. What we have been able to ascertain so far, in the Punjab, is that all these different forms occur mixed up throughout the winter. From the same lot of caterpillars collected on the same date and from the same plot of cotton we have been getting moths with light green, yellow, brown and greyish brown forewings. We are not in a position to state that one particular form exists in definite proportion with the other various forms met with in a particular month of the year.

Storey in his paper gives us hopes of publishing the results of experiments, then in progress, to find out the climatic causes which effect these changes; and certainly they would have been very interesting, but we are not sure if he has published them at all. The annexed table gives some idea of the number of various forms of moths bred out during the winter season. It may be pointed out that the number of moths given in this table does not indicate the total of moths bred out by us in the laboratory. It, however, indicates that only in these cases were observations on their colour variation recorded. Thus these figures are not quite complete, and we hope to be able to give more definite figures later on.

Table showing the number of moths (E. insulana) *bred out with their variations in the colour of the forewing.*

Time of emergence of Moths.	Wings, green or pale green.	Green with yellow dorsal margin.	Green with white dorsal margin.	Green with pink dorsal margin.	Stalk yellow and yellow with green tinge.	Brown.	Brown with green tinge.	Brownish grey.
1920—								
November . . .	13	..	..	..	2	..	..	..
December . . .	25	..	..	..	17	..	..	..
1921—								
January . . .	6	..	..	..	5	..	..	..
February . . .	67	13	6	125	91	8	5	..
March . . .	22	2	4	21	45	17	3	..
April	52	2	6	1	1	..	..	..
November . . .	3	..	3	4	1	1	..	..
December . . .	1	..	..	3	4	1	..	..
1922—								
January . . .	8	2	1	9	4	3	2	..
February . . .	..	..	..	4	4	..	..	..
March . . .	18	6	1	3	6	5	..	..
April	2	..	1	1	..	..	..	..
December . . .	23	2	12	9	2	3	3	..
1923—								
January . . .	12	1	7	14	7	6	4	2

Besides these variations in moths, we find that the cocoons prepared by the caterpillars of *E. insulana* also show a great variety of colours. We get cocoons from pure white to dirty white, creamy white, different shades of yellow, brown and grey, the darkest cocoons being dark sepia. These colours do not seem to depend on climatic conditions, as we find various colours occurring throughout the year. It has been observed that these coloured threads are only present on the outer layer of the fibres of cocoons, the inner layer of silk being nearly always white. This is also proved by the fact that in cases when some caterpillars which had spun their cocoons partly, were disturbed, they left the first cocoon and prepared a second cocoon which was pure white in colour. Also, if the various coloured cocoons be cut open, the inner fibres will be found to consist of white threads. Experiments to find out the relation of the colour in cocoons with environment, temperature and food, etc. are in progress. We have also found caterpillars showing variations in colours in the case of *E. insulana*. Amongst the large collection of caterpillars made, we find mixtures of larvæ, some showing markedly whitish colour, some are more greenish, while others show brownish colouration. These variations are very prominent in caterpillars which are nearly full-grown.

6.—A NOTE ON A NEW COTTON BOLLWORM, *RABILA FRONTALIS*.

By Rao Sahib T. RAMACHANDRA RAO, M.A., F.E.S., *Acting Government Entomologist, Madras.*

In the course of the Pink Bollworm work undertaken at Coimbatore in connection with the enforcement of the Pest Act against the pests of Cambodia cotton in South India, a large number of cotton bolls were received from the districts and examined during the last three years. In the course of such an examination the presence of a new bollworm which differed in habits from the other known kinds, *viz.*, *Platyedra*, *Earias* spp. and *Chloridea*, was brought to light. Mr. Ballard first detected it in Udumalpet Taluq, Coimbatore District, in 1920 and was struck by its resemblance to the African Bollworm, *Diparopsis castanea*, both in the shape and the habits of the larva. Specimens were received in 1921 from Allinagaram, Madura District, and later on a few specimens were collected on Cambodia cotton at Coimbatore. The writer noticed it in small numbers on Cambodia bolls in Tiruchengode Taluq, Salem District, during Pest Act Inspection in September 1922. None of these caterpillars could, however, be reared, in spite of all efforts. In October 1922, the writer had occasion to inspect an area of indigenous perennial cottons (*Gossypium obtusifolium*), known as "*Nadan*" locally, at Karamadai near Coimbatore and, while examining the bolls for bollworm infestation, secured a few specimens of the caterpillars and was able to rear three specimens of moths of which one, however, was deformed. Bolls collected from Karamadai early in January 1923 revealed the presence of young caterpillars in the young bolls, and these are being reared.

For the identification of the species, the writer is indebted to Mr. Bainbrigge Fletcher, Imperial Entomologist, who determined it as *Rabila frontalis*, Wlk., a specimen of which, taken by him in 1913 at Coimbatore, is in Pusa Collection. Mr. Fletcher makes the following remarks as to the identity of the species. "The species is not *Diparopsis castanea*, as Mr. Ballard supposed, but it is evidently *Rabila frontalis*, Wlk. (F. I. Moths, No. 1591) only represented in the British Museum collection by Walker's faded type which was taken in Ceylon. The type (by Hampson's description and figure) differs slightly by the more extensive anastomosis of vein 8 of the hindwing, but that is probably only an individual aberration, and I am satisfied that the Coimbatore

specimens are *Rabila frontalis*. Curiously enough, *Rabila* has the same sort of horny frontal plate which occurs in *Diparopsis*. A similar structure, but rather more accentuated and provided with a chisel-like cutting point, occurs in *Mudaria cornifrons*, the larva of which is common at Pusa in *Bombax* pods. Possibly this frontal process serves some purpose connected with the emergence of the moth (in *Mudaria* the larva pupates under-ground) but it is noteworthy that a parallel structure should occur in three genera, all associated with cotton or the rather closely allied *Bombax*."

The life-history of this moth is not yet worked out, but it is likely that the eggs are laid singly on the bolls. The young caterpillar bores directly into the bolls and is rather stout and thickset. It is pale brown with the shields, which are dark brown, showing rather conspicuously on the light background. The anal shield is especially large and prominent, as also is the prothoracic shield. The full-grown caterpillar is thickset and even fat and is about 20 mm. long. The general colour is usually a light pink. The head is red-brown while the prothoracic shield is large and dark brown in colour with a median light streak. The anal shield is present but comparatively small and inconspicuous as also are the body shields which are quite small. The caterpillar feeds on the entire substance of the boll, devouring both the lint and the seed, and scoops it out completely. The excreta are generally shoved out through the entrance hole in the beginning but later on are cast inside the shell. Each caterpillar would appear to be capable of destroying two or three bolls. When fullfed, the caterpillar leaves the boll and pupates in the ground in a mud cell. The pupa is short and thickset and dark brown in colour and the moths emerged in about three to four weeks in October-November.

The caterpillars were found parasitized by a small blackish *Bracon* which pupated in small oval whitish cocoons.

The moth has been collected so far only from Coimbatore, Salem and Madura Districts and Hampson records it from Ceylon. It appears to breed normally only in the country tree-cottons where it is somewhat more abundant than either *Platyedra* or *Earias* and, though it is interesting at present only as a novelty, yet its resemblance to *Diparopsis* suggests dormant potentialities for harm.

7.—THE AMERICAN COTTON BOLL-WEEVIL: A MENACE TO INDIA.

By T. BAINBRIGGE FLETCHER, R.N., F.L.S., F.E.S., F.Z.S., *Imperial Entomologist.*

The American Cotton-boll Weevil (*Anthonomus grandis*) is one of those pests with whose name we are all very familiar from the frequent references in economic literature to its depredations and control, although we have no first-hand acquaintance with it. Realization of the fact that it has a very good chance of obtaining entrance into India, if it has not already done so, therefore comes to us rather in the nature of a shock.

The Boll Weevil is at present spread throughout practically all the cotton-growing belt of Southern United States, but it was not originally a native of this area. It appears to have been indigenous in the plateau region of Mexico and Central America. Thirty years ago it had spread practically throughout Mexico and about the year 1892 it crossed the boundary into Texas, and by 1894 it had spread to half-a-dozen counties in that State. Since then it has spread continually until now it has practically reached all over the cotton-growing belt. The rate at which it has spread is instructive. During the first ten years after its advent into the United States the annual rate of spread of the weevil was 5,640 square miles. From 1901 to 1911 the annual increase in the infested territory averaged 26,880 square miles. In 1916 it reached 71,800 square miles. By the end of 1921, over 600,000 square miles of territory out of about 705,000 square miles in the cotton-producing belt had been invaded. Of course, all this area does not grow cotton exclusively, in some parts the area devoted to cotton being less than ten per cent. of the whole, but at the end of 1921 eighty-five per cent. had been invaded and this invaded area produces about ninety-five per cent. of the cotton crop of the whole country. The direct loss in non-production of cotton lint and seed is estimated as well in excess of two hundred million dollars annually, while for the four years ending 1920 the average annual loss was estimated at about three hundred million

dollars annually. The damage in individual fields of course varies widely from slight injury to complete destruction of the crop, and a fair idea of the possibilities of loss is afforded by the gains which have been secured in poisoning experiments in which weevil injury has been eliminated; gains of five, six, or even seven hundred pounds of seed cotton per acre are claimed as not unusual and in exceptional instances gains have exceeded one thousand pounds per acre. It will therefore be appreciated that this insect is capable of very serious damage to the cotton crop and therefore it comes into the class of most undesirable aliens that we do not want to see in India.

I have here (*exhibited*) some specimens of the Boll Weevil which Dr. L. O. Howard has very kindly sent at my request and these will give you an idea of what the adult insect looks like. Both colour and size are variable, the length being about 3 to 8 mm. and the colour being light-yellowish when newly-emerged and later on grey, brown, or nearly black. The insect passes the winter as an adult and in the spring and throughout the cotton season the eggs are deposited in cavities formed by eating into the fruit of the cotton-plant. The egg hatches after about three days and the larva feeds in the boll for seven to twelve days, after which it pupates, the pupal stage being three to five days, and the adult female ovipositing about five days after emergence. The whole life-cycle is therefore passed in a period of two to three weeks —a very important point with regard to the rapid multiplication of the species. As with most weevils, the adults are long-lived, the average life being about seven weeks in the hot weather and six months in the winter. The cotton squares are greatly preferred by the adult weevils as food and as places for oviposition and, as long as a large supply of the squares is present, the bolls are not damaged to any serious extent. The females refrain from ovipositing in squares already visited by other females, but, when the beetles are present in large numbers in proportion to the number of squares, several eggs may be deposited in a single square or boll. The adult weevil is mainly diurnal in habits, but there is also some activity by night. It is able to fly but is not attracted to light. One of the most favourable conditions for its existence is stated to be excessive summer rainfall, so that regions with the heaviest precipitation during the cotton-growing months suffer the greatest damage. It will be seen therefore that Indian conditions will be likely to suit this weevil should it obtain a footing in the country.

As regards the probability of its finding its way into India, the position has been accentuated lately by the relatively large imports of American cotton for the use of Indian Mills. During the year ended

30th September 1921, the following importations of American cotton into Bombay took place :—

	Bales.	Tons (approx.)
Direct from New York	110	25
,, New Orleans	900	200
,, Galveston	600	130
,, Texas	300	65
Via Liverpool	60,548	13,000
Via Kobe	375	20
Viâ Osaka	3,145	660
TOTAL	65,978	14,100

Of these, it will be seen that 1910 bales came direct from the infested area in the Southern States, direct steamers from New York taking about one month in transit, steamers *viâ* Japan about seven weeks and *viâ* Liverpool about five weeks.

Even if all these bales were used in the Bombay Mills, there would be some little danger of the weevil getting into Bombay and living there on stray plants of cotton or other Malvaceae, but a large amount of this American cotton goes outside of Bombay to places in cotton-growing areas such as Ahmedabad and Cawnpur. There is thus considerable danger of distribution of the weevils not only around the mills but also along the railway lines *en route*.

So far as we know, the Boll Weevil has not yet secured a footing in the country. We sincerely trust it may not do so, but the present position is an anxious one. It is certainly a case where prevention will be better than cure but prevention on such a large scale is not an easy matter. Fumigation of the bales before shipment is neither practicable nor effective in ensuring that they will be free of weevils when landed. Treatment, whether by fumigation or otherwise, is not easy or inexpensive in practice when thousands of tons are concerned. The position is being watched carefully and will be considered at an early meeting of the Cotton Committee, so it is perhaps premature to say more on this subject.

I have, however, thought it as well to bring the matter before you so that, if you come across any suspicious weevils attacking cotton, you will be in a position to give us early information.

Since writing this paper, I have received from Mr. Burt, Secretary of the Cotton Committee, some more recent figures of importation into

Bombay of American Cotton, forwarded in his letter of 24th January in which he says :—

" Sea-borne trade returns give the total cotton imported from the United Kingdom and America, which may all be assumed to be American cotton, as 12,807 tons for the year ending 31st March 1922. This may be taken as roughly 58,000 bales. The imports for the period April to October 1922 were 2,821 tons corresponding to say 13,000 bales. There were also imports from Japan, probably American cotton, which in 1922 amounted to 446 tons, say 2,000 bales.

" Imports of American cotton into Bombay port as reported by the Bombay Chamber of Commerce were as follows :—

	Bales.
1920-21	81,105
1921-22	23,058
September 1922 to January 1923	1,504

" The Bombay cotton year runs from the 1st September and it is consequently not possible to compare Bombay figures with fiscal year figures direct.

" With the fall of exchange the importation of American cotton fell off. It is a spasmodic business but there has been an import every year since 1900; 1912, 1913, 1921 and 1922 being years with large imports."

I wrote to Dr. Howard, Chief of the Bureau of Entomology, United States of America, in May last year asking him whether in his opinion the weevil was likely to be introduced into this country either in the immature or adult condition along with cotton bales originating in the United States; also whether the adult insect could survive without food for a sufficient length of time to allow it to reach this country, either *via* Liverpool or Japan, or direct from the United States. I also requested him to be good enough to supply me with a number of specimens of the adult insect for distribution so that Entomologists in India might recognize the weevil if they met with it. Dr. Howard referred my letter to Dr. W. D. Hunter of the Bureau of Entomology, United States of America, who replied as follows :—

" Dear Dr. Howard,

" Referring to your note........concerning the danger of the introduction of the boll weevil in India, I should like to make the following comments. The longevity of the adult boll weevil depends on seasonal conditions. In the summer it rarely lives as long as fifty days. In the cooler portions of the year it has been known in numerous cases to live as long as six months. Therefore, as far as the time element is concerned the establishment of the weevil in India by carriage on bales of American cotton would be a distinct possibility.

"The American cotton is wrapped in very coarse jute fibre. The covering gives many opportunities for the boll-weevil or other insects to be carried. Many thousands of the weevils are concentrated around the gins each season, where they may easily make their way to the bales which are lying on platforms awaiting storage.

"The reference works available indicate that the time of cotton planting in India varies from April in Punjab to October in Madras. With such a range in the development of the crop it is quite possible that hibernating weevils carried in bales of cotton would at least occasionally have an opportunity to infest the local cotton.

"Two courses would appear to me to be feasible in eliminating the danger incident to American cotton arriving at Indian ports. One would be to determine by certificates or warehouse receipts that the cotton was more than six months old. The other would be to have it fumigated with hydrocyanic acid gas as a condition of entry. It would not be necessary to have this fumigation in vacuum since the weevils are not to be found within the bales."

In view of the longevity of the adult weevil it becomes increasingly important that measures should be adopted to deal with it at the port of entry. The facts that the adult beetle might be carried in the jute wrapping of the bales, and that the conditions of conveyance in goods vans up-country would be conducive to distributing the beetle, gravely increase the danger of spread. If the insect escaped along the railway line, it would be very likely to find cotton plants on which to establish itself. Fumigation of the bales with hydrocyanic acid gas, or at least of such bales as are not consumed in Bombay, should perhaps be undertaken. The position is a very serious one, and the alternative may be the total prohibition of import of cotton from America.

Can Mr. Hilson tell us whether much Cambodia cotton is exported, and if so, whether the amount exported is sufficient to balance the imports of American long staple cotton? Would it be possible by retaining all the long staple cotton grown in India to do away with the need of importing from America?

The real Cambodia grown in India is not sufficient for the requirements of local mills in Madras and Madura, who have to import American cotton in addition.

If sufficient Cambodia cotton could be produced in the country, the Indian Central Cotton Committee might consider the question of total prohibition of import from America.

A general discussion followed in which Messrs. Milligan, Fletcher, Beeson, G. R. Dutt, Hilson, Husain, Isaac, Iyengar, Ram Gopal,

Ramachandra Rao and Richards took part. It was unanimously accepted that neither certificates nor warehouse receipts showing the age of the cotton (see Dr. Hunter's letter above) would afford adequate protection against the entry of the weevil. The following resolution, proposed by Mr. Richards and seconded by Mr. Hilson, was passed unanimously :—

" The Conference of Entomologists at Pusa, having considered the suggestion made in Dr. W. D. Hunter's communication, of determining " by certificate or warehouse receipts that the cotton was more than six months old," and having concluded that this will not afford adequate protection against the danger of introducing the Cotton Boll Weevil, is of opinion that the Indian Central Cotton Committee should consider the advisability of recommending the total prohibition of cotton from America ; and as an alternative, that all bales containing such cotton should be fumigated at port of entry, and that entry should be restricted to Bombay."

A further discussion took place upon the need of applying immediate precautionary measures, pending a final decision upon the main issue. The measures considered were :—

(*a*) quarantine retention of imported cotton during a specified period at the port of entry,

(*b*) import only after a specified resting period in warehouse in England,

(*c*) immediate removal and destruction of the wrapping of the bales upon landing at the port of entry.

Summary of the discussions.

Total prohibition of import is the only certain safeguard.

Certification generally proves unsatisfactory in practice.

Warehouse receipts are inadequate unless it be proved that there has been no opportunity of reinfection of the bales by contact with more recent bales, (*a*) in the warehouse, (*b*) at the shipping wharf, (*c*) on the ship by cotton consigned to extra-Indian ports.

Fumigation is the alternative which offers the best chance of success.

To ensure absolute safety fumigation should be carried out in the hold prior to the discharge of any cargo, but this would probably prove prohibitive on account of (*a*) the cost of fumigating, (*b*) delay of the ship, (*c*) consequent increased harbour dues.

Fumigation, if done on shore, should be carried out with as little delay as possible after landing, and with the minimum of transportation within the port.

A fumigating plant capable of dealing rapidly with any quantity of bales of cotton likely to be imported should be erected at some suitable place for landing and treatment. Competent supervision would be necessary.

Charges for treatment should be met by the importers.

There would necessarily be some danger of the escape of weevils in landing untreated bales; but so long as this was confined to the docks, or an island in the harbour, the chances that the insects would find suitable plants on which to establish themselves would be remote.

Live insects are unlikely to be found at any distance within the bales; but should they chance to be, the poison fumes would probably not reach them unless the air were first exhausted by a vacuum pump.

While the boll weevil is not known to feed on any plant other than cotton, it is not safe to assume that in a new environment some other plant may not suffice for its establishment.

Until final protective measures are sanctioned, palliative temporary measures should be employed. Such might be :—

(*a*) Quarantine retention. The imported bales would be stored for a specified period in specially screened godowns at the dock, or preferably on an island in the harbour.

(*b*) Import *via* England. The imported bales should have remained for a prescribed period in a warehouse in England, and should be certified to be free of danger of re-infection.

(*c*) Destruction of wrappings of the bales. The jute or other wrappings of the bales should be removed as soon as possible after landing, and at once destroyed in an incinerator. If it is not practicable to re-bale the cotton, the wrappings might be cut away as close as possible to the binding hoops.

Entry should be limited to one port on account of the cost of entailed inspection and supervision.

All cotton bales of American origin should receive treatment whether destined for consumption at the port of entry or elsewhere.

8.—PRELIMINARY OBSERVATIONS ON THE ATTRACTION TO LIGHT OF MOTHS OF SUGARCANE-BORERS.

By DINA NATH, L.AG., *Agricultural Assistant, Punjab Agricultural College, Lyallpur.*

Stray moths of the borers of sugarcane are known to visit ordinary lights. During the year 1922 extensive observations were made in the cane fields at Lyallpur Agricultural Experimental Farm with a view to find out if the positive phototropism of these moths was strong enough to be used for their destruction. We aimed at starting the work early in the season, *i.e.*, during March and April, when these moths emerge from their winter sleep, and entrap them before they had laid eggs. The work, however, was delayed owing to the difficulty of installation, etc., and the experiment was started on the 16th June 1922 and since then the traps have been put out during certain nights of every month right up to January 1923.

The trap consisted of a glass bottle 17-inches long having a diameter of 3·8 inches. The bottle was placed on a stool and over the bottle a large glass funnel was placed to receive the insects which, as soon as they were attracted to light and dashed against the side of the electric bulb, fell down in the bottle through the funnel. Later on, a tin funnel of 15 inches diameter, having a tube of 2 inches diameter, was placed in order to increase the area through which insects could fall down. The bottle served the purpose of a killing bottle which was prepared like an ordinary killing bottle, by using Potassium Cyanide and Plaster of Paris. A 50 C. P. electric bulb was hung in the middle of the funnel. The trap was in action from 8·30 to 12 in the night.

As soon as it grew dark moths began to come to light at about the rate of one after every 2 or 3 minutes. The ground was well lighted for several feet on all sides but the moths usually struck the bulb and fell down in the funnel.

It was found that on still, dark and fairly warm nights insects were attracted in large numbers. Also after rainy days insects were attracted in greater numbers, suggesting that the humidity increased the activity of positively phototropic insects or made them more sensitive to light stimulii.

Results of the experiments.—Collections during 59 nights recorded 3,194 moths of cane borers. Out of these 2,180 were *Chilo simplex* and other species of *Chilo* and *Diatraea*, 451 of *Scirpophaga* and 563 of *Emmalocera*.

Of this total number of 3,194, 1,151, or 36 per cent., were males and 2,043, or 63·9 per cent., were females.

Table I shows the total number of cane borer moths attracted during 59 nights from 16th of June to the end of October. The different species that were attracted are given below :—

TABLE I.

Different species of cane borers taken at a light trap at Agricultural Experimental Farm, Lyallpur, 1922.

Month	No. of nights during which trap was used	*Chilo simplex* and other species of *Chilo* and *Diatrea*				*Scirpophaga*					*Emmalocera* spp			Total
		Males	Females	Total	Per-centage of Females	Males	Fe-males	Per-cent. of Females	Total	Males	Fe-males	Total	Per-cent. of Females	
1922														
June . .	14	51	455	506	89%	43	43	86	50%	24	40	64	62%	656
July . .	17	171	453	624	72%	49	31	80	38%	43	12	55	21%	759
August . .	10	239	446	685	65%	146	43	189	22%	77	61	138	44%	1,012
September .	10	80	239	319	74%	45	51	96	53%	142	115	257	44%	672
October . .	7	20	26	46	56%	...	...	...	...	21	28	49	57%	95
November. .	20	...	...	...	...	...	...	...	...	...	...	...	...	...
December .	25	...	...	...	...	...	...	...	...	...	...	...	...	...
GRAND TOTAL .	...	561	1,619	2,180	74%	283	168	451	37 %	307	256	563	45%	3,194

The results, in so far as they go, are quite interesting. It may be pointed out that electric light was used for experimental purposes only; it is not intended to be employed by the farmers. If we find that tangible results are possible we shall devise some more accessible manner of providing the light stimulus.

We hope to continue this work during the next season and see its effect on the damage done by these borers to sugar cane.

Besides the moth borers we trapped a large variety of insects belonging to practically every Order of the Insecta. Quite a large number of parasites were also attracted. It was noticed that after rain the number of insects collected was very large.

On 23rd June, 20th and 24th July nights, after rain, the insects almost filled the whole bottle, the capacity of which was 3250 cc.; it was impossible to count their numbers and the weight of the living matter in the form of insects was 6 Chk. on 24th July (510·3 grammes).

TABLE II.

Date	Species	Total No. of males and females	No. of females	Gravid	Spent	Per cent. of gravid
27th July 1922	*Chilo simplex* and other species of *Chilo* and *Diatræa*.	81	73	70	3	95·8%
31st July 1922	*Chilo simplex* and other species of *Chilo* and *Diatræa*.	77	44	42	2	95·5%
	Scirpophaga	53	14	14	...	100%
3rd August 1922	*Chilos*, etc.	108	50	48	2	96·9%
	Scirpophaga	42	2	1	1	50%
15th August 1922	*Chilo*, etc.	38	2	2	...	100%
	Scirpophaga	8	1	1	...	100%
17th August 1922	*Chilo*, etc.	49	31	28	3	90·4%
23rd August 1922	*Chilo*, etc.	100	70	65	5	92·9%
16th September 1922	*Chilo*, etc.	57	47	45	2	95·8%

TABLE III.

Showing monthly average temperature (Maximum and Minimum) and Humidity for the years 1921 and 1922.

Month	YEAR 1921			Month	YEAR 1922		
	TEMPERATURE		Humidity		TEMPERATURE		Humidity
	Maximum	Minimum			Maximum	Minimum	
January	70·6	39·6		January	65·4	40·86	84·34
February	77·7	43·9		February	72·0	44·25	85·96
March	81·2	52·1		March	84·6	53·73	35·76
April	103·5	69·6		April	95·0	62·84	46·1
May	108·8	75·8		May	98·7	71·43	83·63
June	106·9	82·9		June	105·55	79·7	51·13
July	105·2	83·4		July	105·16	83·99	59·22
August	96·3	79·1		August	101·34	81·1	62·32
September	98·5	76·8		September	96·74	76·14	70·16
October	90·5	63·5		October	90·36	61·92	58·62
November	82·8	50·9		November	81·2	48·86	69·1
December	69·4	47·1		December	69·08	43·99	86·54

TABLE IV.

Meteorological data arranged by dates of collection.

Month and date	*Chilo simplex* and other spp.			*Scirpophaga* spp.			*Emmalocera* spp.			Grand Total	Temperature			Remarks
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Total Moths.	Maximum	Minimum	Average Humidity	
June 1922—														
16th	..	7	7	10	6	16	1	..	1	24	45·1	85·2	33	
17th	..	4	4	8	5	13	2	2	4	21	113·8	87·2	36	
18th	4	10	14	4	4	8	4	2	6	28	114·1	87·5	41	Besides the moth borers several other insects were attracted, largest number of these were Acrididæ (Epacromia spp.) Cockroaches and Elateridæ, Scarabæidæ, Carabidæ and Myllocerus.
19th	2	14	16	5	4	9	3	2	5	30	115·6	88·7	48	
20th	3	20	23	1	1	2	1	1	2	27	110·3	88·2	51	
21st	4	30	34	3	4	7	1	2	3	44	108·7	87·7	47	
22nd	1	35	33	2	4	6	1	1	2	44	109	88·7	47	Rain during the evening.
23rd	..	25	25	1	2	3	2	4	6	34	108·5	76·7	84	Rain during the morning and noon. Insects came in very large numbers, Jassids, Diptera (gnats and small mosquitos). *Gryllus*, the little Tridactylinæ Pentatomidæ Rutelidæ and other Neuroptera (Ephemeridæ) were specially many. Pyralidæ and Noctuidæ moths were also attracted in large numbers.

24th .	2	58	60	2	3	5	..	..	..	65	98·3	77·5	62	Cloudy. Insects were attracted in sufficient number.
25th .	16	162	178	2	3	5	4	20	24	227	106·8	84·5	51	
27th .	14	63	77	3	4	7	3	4	7	91	104·8	76·9	69	Rain on 26th June 1922. Heavy storm and rain in the evening. Moths 257. Other Elateridæ, Dynastidæ Cicindelidæ 259 white ants 197. Antlion 25 winged ants Scarabæidæ 40 winged ants 100, small beetles Diptera.
28th .	4	16	20	2	2	4	1	2	3	27	97·3	71·2	77	
29th .	1	4	5	..	1	1	1	..	1	7	87·3	73·2	84	
30th .	..	7	7	..	..	..	..	..	..	7	95·3	78·7	74	Cicindelidæ Elateridæ, Scarabæidæ, Melo lonthidæ, Bostrychidæ, white ants.
July 1922—														
1st .	1	2	3	..	..	..	1	..	1	4	91·6	72·1	92	
4th .	2	13	15	..	..	..	..	..	..	15	100·3	82·3	70	Heavy storm.
5th .	..	6	6	..	..	..	..	..	..	6	103·3	84·7	66	Moths 178 Ant lion. Parasites and other bugs.
7th .	2	15	17	2	1	3	8	..	8	28	95·1	76·2	62	
8th .	..	..	..	1	2	3	4	5	9	12	99·9	87·4	58	
9th .	..	..	..	..	..	..	..	..	..	..	104·6	84·2	48	
12th .	2	15	17	2	1	3	4	4	8	28	112·1	88·5	49	Night (during which the trap was used) was very warm. Insects were sufficiently large. Besides the other common insects Chrysopa Redermine moth and other Noctuidæ Myllocerus, Elateridæ Carabidæ Jassids and other Pentatomidæ.
14th	6	47	53	..	..	..	..	..	..	53	108·4	87·5	44	Cicindelidæ and other acquatic beetles were specially large.
TOTAL .	64	553	613	48	47	95	41	49	90	609				

TABLE IV—*contd.*

Meteorological data arranged by dates of collection—contd.

Month and date	*Chilo simplex* and other spp.			*Scirpophaga* spp.			*Emmalocera* spp.			Grand Total	Temperature.		Average Humidity	Remarks
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Total Moths	Maximum	Minimum		
July 1922—														
15th .	10	15	25	..	..	..	..	..	..	25	113·1	87·7	44	No Scirpophaga from middle of July to the end. Larvæ were found from the field.
17th .	13	7	20	..	..	..	4	..	4	24	103·9	84·4	66	
18th .	42	24	66		..	..	6	..	6	72	105·7	88·3	44	Rain on 19th evening.
20th .	2	11	13	..	..	..	..	..	..	13	105·3	75·6	87	Too many insects.
24th .	4	45	49	..	..	..	4	..	4	53	108·1	87·4	63	Rain on 23rd July 1923. Scarabidæ more than thousand ant-lion grand predaceous beetles (carabidæ) Cockchafer, Mylocerus and other Noctuid moths were in large numbers.
25th .	25	101	126	..	..	..	..	..	..	126	107·6	88·8	57	Jassidæ in very large numbers. Sugarcane borers in very large numbers.
27th .	8	73	81	..	..	..	7	3	10	91	105·3	77	71	Rain on 26th evening. Very large numbers of insects.
30th .	29	27	56	5	13	18	..	..	..	74	105·5	86·1	70	
31st .	35	42	77	39	14	53	5	..	5	135	101	77	95	
Aug. 1922—														
1st .	25	36	61	10	2	12	3	4	7	80	91·6	72·1	92	

3rd	58	50	108	40	2	42	8	..	8	158	92·6	77·3	67	
15th .	36	2	38	7	1	8	..	1	1	47	104	83·6	60	
16th .	15	25	40	33	13	46	18	25	43	129	104·2	83·4	52	
17th .	18	31	49	33	3	36	8	15	23	108	105·2	84·3	52	
22nd .	30	80	110	7	6	13	20	3	23	146	96·9	80·3	67	
23rd .	30	70	100	4	9	13	4	5	9	122	101·7	84·3	64	
24th .	15	110	125	7	2	9	3	2	5	139	104·6	85·1	61	
28th .	8	19	27	1	3	4	9	1	10	41	100·0	82·7	55	
31st .	4	23	27	4	2	6	4	5	9	42	105·7	83·1	52	
Sept. 1922—														
8th .	2	5	7	2	5	7	6	7	13	27	91·6	76·3	89	
13th .	2	4	6	3	9	12	9	16	15	43	103·6	85·2	66	
14th .	1	6	7	3	4	7	11	5	15	29	105·1	82·1	62	
TOTAL .	412	806	1,218	198	88	286	120	91	220	1,724				
Sept. 1922—														
16th .	10	47	57	19	11	30	18	..	18	105	84·1	75·8	93	Cloudy. Slight rain on 16th September 1922.
25th .	20	45	65	5	9	14	19	4	23	102	101·5	70·2	52	
26th .	21	88	109	3	1	4	7	8	15	128	99·6	69·0	51	
27th .	10	25	35	4	9	13	20	15	35	83	96·5	70·3	55	
28th .	9	11	20	..	..	..	30	29	59	79	95·6	70·9	59	
29th .	3	5	8	6	3	9	10	23	33	50	95	73·2	63	
30th .	2	3	5	..	..	..	12	9	21	26	95·8	73·2	55	

TABLE IV—*concld.*

Meteorological data arranged by dates of collection—concld.

Month and date	*Chilo simplex* and other spp.			*Scirpophaga* spp.			*Emmalocera* spp.			TEMPERATURE.			Average Humidity	REMARKS
	Male	Female	Total	Male	Female	Total	Male.	Female	Total	Grand Total	Maximum	Minimum		
										Total Moths				
Oct. 1922—														
7th .	5	6	11	..	..	..	1	2	3	14	77·4	61·5	74	
14th .	3	2	5	..	..	..	1	9	10	15	92·1	65·3	56	Very small number of insects cut worms were attracted to light.
20th .	1	2	3	..	..	..	5	1	6	w 9	90·3	58·2	40	Do.
22nd .	2	3	5	..	..	..	6	7	13	18	91·1	55·3	61	No Scirpophaga moth was attracted. Emmalocera moths were however in fairly good number.
24th .	1	2	3	..	..	..	4	1	5	8	91·4	59·1	64	
25th .	2	4	6	..	..	..	2	3	5	11	92·3	60·1	61	
26th .	2	2	4	..	..	..	1	2	3	7	92·4	60·2	56	
27th .	4	5	9	..	..	..	1	3	4	13	92	60·1	72	
TOTAL .	95	250	345	37	33	70	137	116	253	668				
GRAND TOTAL	571	1,609w	2,180	283	168	451	307	256	563	3,194				

Trap was used from 8 P.M. to 12 P.M. — 8 P.M. to 12 P.M.

8 P.M. to 12 P.M. — 8 P.M. to 12 P.M.

8 P.M. to 12 P.M. — 8 P.M. to 12 P.M.

9.—A NEW REMEDY FOR SUGARCANE BORERS: A PRELIMINARY NOTE.

By DR. K. KUNHIKANNAN, M.A., PH.D., F.E.S., *Senior Assistant Entomologist, Mysore.*

I have had under investigation for over four years the various species of borers attacking cane in Mysore. There are at least six species belonging to three different genera. *Diatraea* is represented by at least three, *Sesamia* by one and *Scirpophaga* by two. Several of the remedies that have been tried in other parts of the World were tested, but without success. The cutting out of "Dead hearts" has been found difficult and impracticable on a large scale and moreover has not yielded satisfactory results. The egg-masses are difficult to detect. Several other remedies were also tried but with more or less similar results. A new line of attack was then followed which has yielded very encouraging results.

This remedy consists in trapping the adult moths themselves. Several heaps of cane trash, no more than what can be pulled out by the hand, are placed in appropriate situations in the cane field. The moths that fly to the young cane field at night seek these shelters to pass the day and they are easily caught and killed by one who goes over the heap during the warm hours of the day. A boy can go over all the heaps in a five-acre plot. The work is continued for about two months from the day the young shoots first come out of the ground. The moths do not fly, being dazed by the light, and are easily caught and killed. In this way damage was reduced to as low as 2 to 5 per cent. in an area of 12 acres of cane where 50 per cent. loss of the young shoots was normal for years. The method has yielded equally good results in two other localities.

The remedy requires a man to go over the field daily for two months for every five acres of cane. Experiments are now in progress to attract moths to traps from which escape is impossible once the moths get in. If these traps are successful the remedy will be simplified very much further, but, even as it is, the labour involved is so little that the remedy may be adopted generally in India and in other parts of the world where wages for unskilled labour are low.

Among other advantages of the remedy may be mentioned the fact that it is of little consequence whether the setts planted are infested or not. Nor need the work of destroying the moths be done in co-opera-

tion by all the cane growers in a locality. It would of course be an advantage if all the canes in the locality are planted nearly about the same time and destruction of the moths is done on a co-operative basis but, even when co-operation is not forthcoming, the man who cares to destroy the moths in his own field need have no fear that the effect of his work may be neutralized by the indifference of others. The presence of alternative host-plants in the neighbourhood is also of little consequence.

In the discussion on this paper, Dr. K. Kannan was asked whether the attraction to the trash heaps was due to their affording shelter or to any particular smell; whether the trash must be examined daily and if so whether this would be practicable; what was the cost of the work per acre; and whether it would not be difficult to ensure persistence in treatment in actual practice. Dr. K. Kannan replied that the attraction appeared to be largely that of affording shelter although smell might play some part, as it was observed that trash heaps were more attractive to the insects than heaps of weeds in similar positions. The trash heaps must be examined daily after the sun is well up, at which time the moths are loath to fly, but this does not render the method impracticable from the point of view of expense as boys could very well do the work at an average cost, over two-and-a-half months, of Rs. 3 per acre. Moreover, as sugarcane holdings were usually small, the work could readily be done by a member of the *raiyat's* family. In Mysore no difficulty has been experienced in ensuring persistence in the work. Dr. K. Kannan also stated that he was experimenting with traps of simple construction such as could easily be made by the cultivator, in the hope of eliminating daily inspection. In reply to further questions as to the species and the condition of the ovaries of the trapped moths, Dr. Kannan replied that many species of insects sheltered in the trap in addition to *Diatraea* sp. and *Chilo* sp. A great majority of the females of the sugarcane borer moths were in a gravid condition; in some cases a hundred per cent.; and laboratory tests demonstrated that they were ready to lay eggs.

10.—A PRELIMINARY NOTE ON THE BORERS OF SUGARCANE, RICE, ETC., IN BURMA.

By C. C. Ghosh, B.A., F.E.S., *Assistant Entomologist, Burma.*

(Plates 3 and 4.)

Introductory.—A good deal of information has already been published on these pests occurring in India in the following two papers, *viz.*—(1) " Borers in Sugarcane, Rice, etc." (*Proceedings of the Third Entomological Meeting*, Pusa, 1919 ; also published as *Pusa Bulletin No. 102*), (2) " Supplementary observations on Borers in Sugarcane, Rice, etc." (*Proceedings of the Fourth Entomological Meeting*, Pusa, 1921 ; also published as *Pusa Bulletin No. 134*).

This note is intended to show which of the pests dealt with in the above two papers have been observed to occur in Burma in the course of the last two years. Some, including a few of the major pests, have not yet been met with in this Province while a few new ones have been found. Notes on the behaviour, so far observed, of all those which occur have been added. The observations are mostly confined to the cultivated crops. A systematic inquiry into the possible wild food-plants has not yet been made. The same order of treatment is followed as in the above-mentioned publications.

The agents of damage.

All the agents are included as in the above publications, producing external symptoms of " dead heart " similar to those caused by the borers proper and therefore likely to be confused with the latter.

I.—Fungal diseases.

Fungal diseases producing " dead hearts "(apart from smut) are common in sugarcane in all stages of growth. Their prevalence will be understood from the fact that in the neighbourhood of Pyinmana in December 1921 only about ten per cent. of the grown canes (then being harvested) with " dead heart " were affected by the top shoot borer and the rest by fungal diseases. Similar conditions have been observed at Tatkon and Hmawbi.

Fungal diseases are very common on rice as well and are frequently identified with the borer pests by the people through mistake. They go under the common names of *gwabo*, *gwinna*, etc., while the stem borers proper are called *Sitpo*, *i.e.*, joint-worm. The former names, however, are comprehensively used by the majority to include all sorts of affections in the plants. The symptoms of borer attack are quite distinct and are understood by many cultivators. The *Sitpo* causes the heart shoot or the ear to dry and turn yellow or white, the other parts remaining normal. It does not occur in patches and is scattered throughout the field. There is no discoloration in any part of the plants. The young plants tiller normally. The fungal diseases may indicate their presence by yellow patches in the fields while the plants are young. They, however, generally appear when the plants come into ear. The affected plants begin to dwindle down and turn black as if the field has been scorched by fire. The effects are the following :—(*a*) in the worst cases the ears usually fail to come out or one ear may emerge out of 4 to 8 plants ; (*b*) in the ears which come out some or all the grains may fail to develop ; (*c*) the grains which are formed show a dark discoloration to a greater or less extent. The discoloured grains break in milling and do not find a market unless mixed with good grains which therefore have to be sold at a discount.

These diseases usually occur in patches or may affect whole blocks or entire fields. The conditions which favour their prevalence in this manner are not understood. There was a bad and widespread infestation in 1921 in the Mon canals area. But without any treatment and precaution a good crop was obtained in 1922. The presence of the diseases could however be detected in individual plants even in fields bearing a first-class crop. According to the experience of the cultivators at Pwinbyu the diseases occur about once in ten years. This is apparently the experience in other places as well. Affected plants and ears submitted for examination to the Imperial Mycologist, Pusa, were reported to be suffering from *Cephalosporium* and *Sclerotium oryzae*. *Sitpo* may and does occur in the plants affected by these diseases and has led many to identify it with the cause of the diseases.

II.—The external agents of damage.

1. Termites (white ants) are common in some places on setts as well as on growing canes.

2. Mole crickets have not so far been reported or observed to cause any damage to sugarcane.

3. *Beetle grubs.*—The grubs of the following two beetles have been definitely observed to work among the roots of sugarcane, *Andropogon*,

millets, etc., causing " dead hearts " or killing the plants outright. Both have to be added to the lists given in the publications named above.

(1) *Anomala antiqua* (Mandalay Insectary, C. S. 56). A separate note has been written about it. [See page 105.]

(2) *Holotrichia* sp. (Mandalay Insectary, C. S. Nos. 113, 116 and C. S. No. 53). The adult beetles have not so far been observed to behave as a pest of any cultivated crop like *Anomala antiqua*. But the grubs have proved very injurious and are of regular occurrence in large numbers. In Kyaukse district they are very active among sugarcane roots about June-July and kill many young plants, leading to many bare patches in the fields. During the last two years they have been observed to occur in large numbers about July-August in *Andropogon* (*Pyaung*) fields in the Mandalay Farm and in the neighbourhood. They are well known to the people under the common name of *podi-gaung*. Young plants, as well as those up to about 2 or 3 feet high, are gnawed at the roots and ultimately killed. The grubs are found by turning over the surface of the earth. Large fields about five to ten acres in area have been observed to be full of them. The grubs have been found similarly to gnaw and kill maize, pigeon pea (*Cajanus indicus*, *pe-si-ngon*), *Hibiscus esculentus* (*yon-badi-bin*) and *Hibiscus cannabinus* (*chin-boung-bin*). They also occur among grass roots, in farm yard manure heaps and under leaf mould.

4. *Beetles.*—A form of damage to sugarcane leading to " dead heart " and observed near Pyinmana in June 1922 was believed to be due to *Oryctes rhinoceros* and *Xylotrupes gideon*, both of which are very common in the neighbourhood. The shoots of a thick variety of cane were gnawed into at the sides above ground. No other agent could be imagined. About 10 to 15 per cent. of the plants were affected.

Gnawing at the side in the above manner has been observed occasionally in many places on young paddy leading to "dead heart," on grown paddy at the neck leading to dry ear and on *Saccharum* and Guinea grasses at the neck leading to " dead heart." The damage appears to be due to an insect like a grass hopper or a beetle feeding at the part affected. It is not extensive and is scattered here and there. The agent is unknown.

III.—The borers.

Foodplants.—Rice is of course the most important. Unlike the conditions in India, some variety or other of paddy is grown, especially in

Upper Burma, throughout the year. Broadly speaking, the following are the kinds with the time of the year when cultivated.

Mayin.—December to June (around lakes or other accumulations of water).

Kaukty and *Kauk-yin.*—March to August (usually under canal irrigation).

Kauklat.—July to November.

Kaukkyi.—July to February.

Over the most part of Lower Burma, there is no paddy in the field from about February to about May. *Mayin* however is known to be grown here and there. Sugarcane is of course a whole year's crop. *Andropogon* and maize are grown largely in Upper Burma and are found in this tract even in the hot weather in suitable places like river banks and beds and where irrigation is available. Various kinds of millets are also grown. Grasses such as *Saccharum*, *Imperata*, *Panicum*, etc., are common.

It will therefore appear that food plants are available practically throughout the year. Nowhere is there a prolonged period of intense cold. These conditions remove the necessity of prolonged hibernation or rest.

The borers so far observed are listed below under the different food-plants.

Rice—

Pachydiplosis oryzae.

Schoenobius bipunctifer (*S. incertellus*).

Sesamia inferens.

Diatroea sp. (C. S. 1674).

Chilo oryzae.

N.B.—The most injurious *Chilo simplex*, observed in India, has not been found although specially looked for.

Sugarcane—

Diatraea auricilia.

Argyria tumidicostalis.

Sesamia inferens.

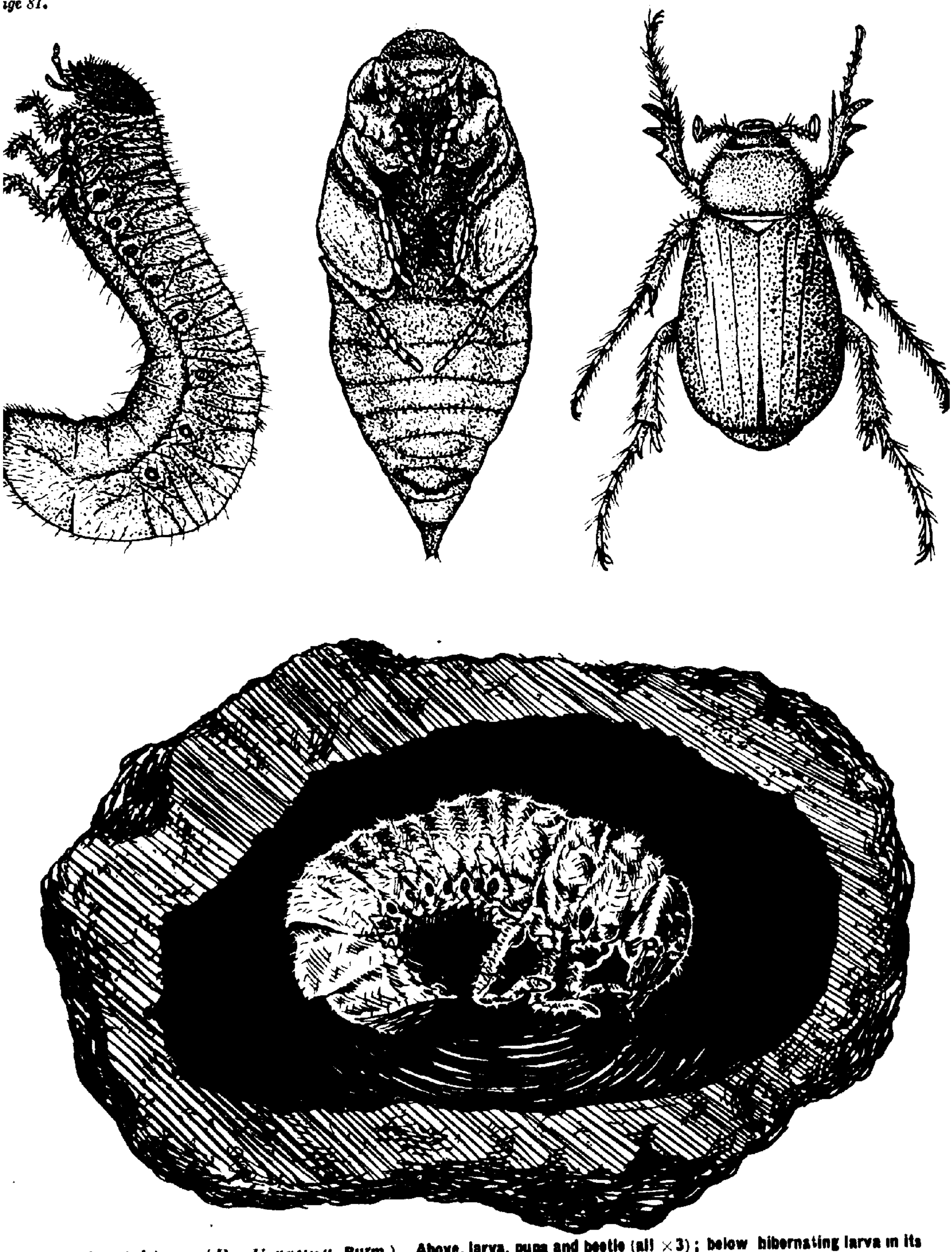
Scirpophaga xanthogastrella.

A Curculionid.

N.B.—Two of the most injurious borers in India, *viz.*, *Emmalocera depressella* and *Diatraea venosata*, have not been found, although specially looked for.

Andropogon (*Pyaung*).—Anthomyiad flies in young plants. No borer on advanced plants has yet been met with. No borer has been observed in maize too.

N.B.—Neither of the two real pests in India, *viz.*, *Chilo simplex* and *Diatraea venosata*, has been found, though especially looked for.



Holotrichia sp. (*Po-di-gaung*, Burm.). Above, larva, pupa and beetle (all $\times 3$); below hibernating larva in its natural cell ($\times 3\frac{1}{2}$).

Panicum crus-galli (*Mye-thi-bin*), *a grass which grows among Mayin paddy.*—A Pyralid borer (Mandalay Insectary, C. S. No. 121).

Imperata cylindrica (*growing on embankments*), *Diatraea auricilia.*—The borers referred to under N.B. above are so common in India that, in spite of the inquiry not having been extended to all possible areas and wild food plants, it would probably not be unsafe to conclude that they are absent from Burma.

Notes on life-history and habits.

Holotrichia sp. (Po-di-gaung) (Mandalay Insectary C. S. No. 113 and 116 and O. S. No. 53). (Plate 3).

A large number of grubs, collected in July-August 1921 from *Andropogon* fields in the Mandalay Farm and other places, were under observation in the Insectary and also in the *Andropogon* field itself. They went into hibernation about October. Hibernating grubs could be collected from the above field and also in sugarcane fields at Singaing in Kyaukse district. They pupated and attained the adult state in March both in the Insectary and in the field. The beetles however continued to rest in the pupal cells, as could be ascertained by digging and examining the field occasionally, until it rained on the 24th April 1922. On the 25th evening many beetles came to light. A strong Storm King Lantern burning petrol was placed in front of the bungalow and an ordinary kerosine Dietz lantern in the compound behind the bungalow. None came to the kerosine lantern. The beetles began to appear a short while after dusk, at about 7-30 P.M., and 97 arrived near the gasoline lantern by 8-30 P.M. No others came after that although the observation was continued till 9-15 P.M. The beetles also came to electric lights. The next evening too they were coming to lights. After dusk a visit was paid to the *Andropogon* field under observation. There was a loud humming noise caused by the beetles which were still on the wing. The shrubs on the border of the field were literally covered with innumerable beetles and were bent with their weight. Almost all the beetles were mating, the females retaining hold on the branches and leaves and the males hanging down in the air passively. A Storm King gasoline lantern was now brought and placed near the bushes. The beetles were perfectly unmoved. A number of them were dislodged, some being thrown into the canal. The mating couples floated passively, the females occasionally making attempts at catching hold of grasses etc. Almost all the beetles had settled down by now and hardly any were obtained at the light.

It was evident from observations during successive nights that not even one per cent. of the beetles present in the locality were attracted to lights.

The beetles swarmed evidently for mating and were not observed to feed on the plants on which they congregated. They dispersed and laid eggs, more than half-grown grubs being found within about the next two months in fresh *Andropogon* fields.

As in the case of *Anomala antiqua*, the succeeding periods of drought checked the activities of these beetles too. The number which swarmed later on was distinctly less.

This is practically the only serious pest of *Andropogon*, maize, etc., in the neighbourhood of Mandalay.

Anthomyiad flies.

(Illustration in Report of Third Entomology Meeting, 1919, plate 29).

These have so far been observed to occur on young *Andropogon*, the maggots boring inside and causing the heart-shoot to dry. The damage is not serious.

Pachydiplosis oryzae.

(*Kyet-thun-meik* or "onion-shoot" disease) (Illustration in the Report of Third Entomological Meeting, 1919, plate 30).

It was reported from Kyunhla Township, Shwebo district, in October 1922 and again from Shwebo Township of the same district in December of the same year.

The Township Officer, Kyunhla, reported that infection was usually in patches, was irrespective of the condition of the soil and was observed during the past three years. Both *Kaukalt* (sown about July) and *Kaukkyi* (sown about June) crops were affected, the disease appearing about the middle of September in both, when the plants were about two to three feet in height. The plants did not bear and withered away about *Pyatho* or *Tabodwe* (January). In Shwebo Township about 500 acres under irrigation were reported to be infested in December.

A detailed account of this pest will be found in the Report of Fourth Entomological Meeting, 1921.

Schoenobius incertellus (bipunctifer.)

(*Sitpo, i.e.*, joint worm and *Leikpya*) (Illustration in the Report of Third Entomological Meeting, 1919, plate 43).

Of all the stem-borers this is the most wide-spread and occurs throughout the year in all varieties of paddy. It has been observed to

be active throughout the year in the fields. In the laboratory, too, moths emerged in all the months. But the majority of the caterpillars occurring in winter pass through a period of hibernation and a very small percentage through a period of aestivation as well.

The combined damage to paddy by this and the following three borers is estimated to be less than one per cent. On the experience of the past three paddy seasons over different places in the whole of the Province the loss may be stated to be somewhere about 0·1 per cent. Individual fields or varieties occasionally suffer more. The worst so far observed was 6·5 per cent. in the worst of the paddy varieties in the Hmawbi Farm in 1920-21. The following season in the same farm it was about 2 per cent., while the average of the whole farm would be about ·01 per cent. In the 1922-23 season borers were still less.

So far as can be made out at present the stem-borers do not appear to be serious pests of the main crops of paddy. The wide spread nature of the crop is a preventive of damage by these pests.

Leik-pya.—Under certain circumstances, however, *Schoenobius bipunctifer* has been observed to cause very serious damage. *Mayin* paddy is grown round a large lake at Paunglin in Minbu district, being sown in seedbeds in December, transplanted in March-April and harvested in June. For miles around this lake *Kaukkyi* is the only crop from July to January or February. In March, as soon as it gets warm, innumerable moths from caterpillars hibernating in the *Kaukkyi* stubbles concentrate on and literally cover with eggclusters the *Mayin* plants at Paunglin, being known as the *leik-pya* pest. Consequently very severe damage follows. The *Mayin* paddy in Mandalay and Kyaukse districts and Myinmu sub-division of the Sagaing district have not been observed to suffer in this manner as it is grown extensively in the two first-named districts where it is further helped by the presence of the equally extensive *Kaukty* crop. In Myinmu it is not preceded by any kind of paddy. In about 6000 *Kaukkyi* stubbles examined in April in the area surrounding Paunglin only two *Schoenobius* caterpillars were observed still resting.

Sesamia inferens.

(Illustration in the Report of Third Entomological Meeting, 1919, plates 36 and 37.)

The caterpillars have been observed to occur throughout the year in company with the above in all varieties of paddy and also in sugarcane. The attack in no case has been found to be serious.

Diatraea sp. (C. S. No. 1674) (*Sitpo*).

(Illustration in the Report of Third Entomological Meeting, 1919, plates 55 and 56.)

The caterpillars have been observed to occur only in paddy so far. None of those collected in November and December hibernated. All emerged as moths in the laboratory in December and January. The seasonal and detailed history are unknown in Burma.

Chilo oryzae (*Sitpo*).

(Illustration in the Report of Third Entomological Meeting, 1919, plates 57 and 58.)

The caterpillars were observed only once, in November 1921, in paddy stems on the Mandalay Farm. The detailed and seasonal history in Burma are unknown.

Argyria tumidicostalis.

(Illustration in the Report of Third Entomological Meeting, 1919, plates 52, 53 and 54.)

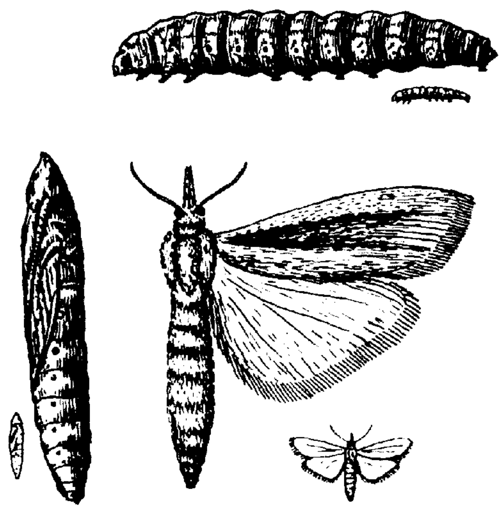
This is the only serious pest of grown sugarcane and seldom occurs on young canes. In India it is confined to Eastern Bengal and Assam. In Burma it has been observed to be present everywhere. Some at least of the caterpillars are apparently active throughout the year. In the laboratory moths emergėd in January and February while a few caterpillars rested from about December to March.

Large numbers of caterpillars occur in individual canes or clumps which suffer badly. The pest is never widely spread throughout the field. Timely removal of the affected canes is the only measure which suggests itself.

Diatraea auricilia.

(Illustration in plates 48 and 49 of the Report of Third Entomological Meeting and plate 19 of the Report of Fourth Entomological Meeting.)

This is a pest mainly of young cane, rarely occurring in grown cane. The seasonal history in Burma is not well understood yet. The caterpillars collected from December to June developed into moths without resting. Except on one occasion near Hmawbi they have not been observed to occur in injurious numbers.



Pyralid Borer (Burma C. S. No. 121) in stem of *Panicum crus-galli*, Larva, pupa, and moth. (The smaller figures show the natural sizes.)

Scirpophaga xanthogastrella.

(Illustration in plates 41, 42 and 68 in the Report of Third Entomological Meeting, 1919.)

It is the top-shoot borer of sugarcane, occurring in canes of all stages of growth. It has not so far been observed above Pyinmana and during the last two years it occurred in insignificant numbers. (See the remarks under fungal diseases above.)

A Curculionid borer in sugarcane.

One weevil grub was observed boring a stunted young cane which was dead, but not dry, at Singaing in December 1921. It could not pupate successfully. No other grub has been met with since. No such grub was observed in India.

Pyralid borer (Plate 4).

(Mandalay Insectary C. S. No. 121.)

The grasses (*Panicum crus-galli*) have a solid cyperaceous stem. The caterpillars bore at the basal part and pupate inside the stem in their tunnels which then communicate externally, the opening being closed with a thin layer of the epidermis.

This is a new borer which has to be added to the list given in the above-mentioned publications. The caterpillars were found in April. All emerged as moths by June.

A fullgrown caterpillar is about 13 mm. long and 2 mm. across the middle of the body, which is cylindrical, has distinct segments and tapers towards both extremities. The head is smaller than the following segment and shiny yellow in colour. The prothoracic plate is faintly distinguishable by a few shiny chitinous patches of the same colour as the head. The general colour of the body is pale green with five faint brownish stripes, one mid-dorsal and two on each side above the line of the spiracles. In some specimens the stripes are distinct. The spiracles are round, brown, the first three abdominal pairs being uncommonly large and all diminishing in size from the first abdominal pair. The anal segment has a triangular brown plate with its tip slightly raised upwards. The thoracic legs are shiny, brown. The prolegs are very small so that the ventral parts touch the surface on which the larva walks ; the hooklets are minute and arranged in a circle on the abdominal prolegs. If the caterpillar is placed on its back or picked

up with the hand the prolegs are drawn into the body. Pupating caterpillars change their colour to pale yellow.

The pupa is about 10 mm. long and about 2 mm. across the middle of the body which is cylindrical, the two extremities being tapering. The head end is protruded into a snout. The colour is pale greenish-yellow. As in the larva, the spiracles are brown, round and diminish in size gradually and markedly from the first abdominal pair. The colour changes to brown with maturity.

11.—A NOTE ON THE RICE HISPA (*HISPA ARMIGERA*).

By C. C. GHOSH, B.A., F.E.S., *Assistant Entomologist, Burma.*

The Rice Hispa occurs throughout Burma. But its behaviour in Upper Burma is quite different from that in Lower Burma. In the former tract one would hardly class it as a pest. In the sea-coast districts of Lower Burma, however, it is a real pest of regular occurrence practically every year. Last year the writer visited an infested area situated about seven miles from the sea near Alangon, within Thongwa Township, in Hanthawaddy district. The place is a vast level expanse of land with hardly any trees except near villages which are situated long distances apart. Practically the whole area remains under water during the Rains. Early in June the lands are prepared by cutting away grasses and driving a plough at the most about three times. The seeds are now broad-casted and, if the plants grow, no further attention is paid to them till harvesting time. If some plants die owing to submergence or other causes, the gaps are filled by transplants from places where growth is thick. Transplantation may be necessary in this manner until about September. Cultivation being easy, individual owners cultivate large areas, as much as 200 to 500 acres or even more. In most cases the Burman owners (each possessing several hundred, even thousand acres) let out the lands in yearly leases to cultivators, mostly Indians, who come from a distance, do the sowing and trans planting, and go back home, returning to harvest.

The Rice Hispa occurs here every year about July. The beetles come in swarms which settle here and there. They nibble the green tissue, producing longitudinal whitish or yellow streaks on the blades, and at the same time deposit eggs on the apical parts of the leaves. The grubs which hatch from these eggs mine the leaves, producing dry yellow patches. As from three to seven grubs were feeding inside each leaf, the entire upper part was yellow and dry. In this manner large patches, at some places two or three acres in area, had become wholly yellow by the beginning of September. The period of the life-cycle from egg to imago being short (about two weeks) the beetles multiply rapidly. At this time enormous numbers of beetles were emerging from the infested fields every day and spreading.

The pest was present only on the east side of the village, the three other sides not being affected. The total of all the infested patches would be about 50 to 60 acres.

The cultivators know from their experience that the plants are not wholly killed but throw up fresh shoots afterwards and bear ears. The beetles leave the plants which get yellow and seek food elsewhere, thus giving them a chance to grow. But the yield is affected to various extents up to about 50 per cent. in the worst cases. Of the two varieties of paddy grown here, *viz. Kamakyi* and *Ngasein* (local names) the latter is said to be affected less. But as the former fetches a better price than and gives about an equal outturn to *Ngasein*, all go in for *Kamakyi*. In Upper Burma the beetles have been observed to prefer the local *Ngasein* to other varieties.

The cultivators chafe at the loss caused by the pest and sometimes ask for help to get rid of it but seldom do anything themselves, being at the time busy with the transplanting operations. Parasites, climatic change and hardening of the plants have their effect and by October the pest is said to cease to do any more harm.

The first thing which seemed necessary to do was to cut off the dry upper parts of the leaves and burn them with the grubs and the pupae contained in them, thus preventing the daily increase in the number of the beetles. The next step was to sweep up the beetles with hand nets. The hand nets which could be easily made and used with the best effect are thus prepared. A piece of cloth is made into a bag and sewn to a bamboo or cane ring and a handle tied across the mouth. Deeper flaps than about 1½ feet were inconvenient to use. By swinging the net from right to left and left to right with both hands a man can easily cover about five feet. The type of large bags usually recommended is practically useless. It is necessary to brush the plants with some force to be able to dislodge the beetles, and this is hardly possible with large nets. For the same reason, hand nets with the handle tied across the mouth were found to be much better than those ordinarily recommended with the handle fixed at one end ; besides, the latter were not easy to make. Dry conditions were the best for catching the beetles when they got easily dislodged into the nets which, too, were best kept dry. When it rained the beetles clung so tightly to the leaves that very few could be shaken off.

The best thing of course would be to sweep up the beetles when they first appear and then to be on the look out for any dry tops which should be cut off and burnt.

The beetles were observed breeding on wild grasses growing in uncultivated parts among paddy fields. It would be hopeless to ask any one to tackle them there.

12.—A NOTE ON *NYMPHULA DEPUNCTALIS* (RICE CASE WORM).

By C. C. Ghosh, B.A., F.E.S., *Assistant Entomologist, Burma.*

This insect is of common occurrence in Lower Burma about July and is of hardly any importance in Upper Burma. Seed beds as well as transplanted and broad-casted seedlings are affected. The caterpillars nibble away the leaf tissue, causing the leaves to turn yellow and dry. Entire plots and large patches dry in this manner but the plants are not killed; however, they lose in vigour and are retarded in growth. A block planted wholly with badly-affected seedlings last year gave the following results in the Hmawbi Experimental Farm.

	Area in acres.	Total out-turn in lbs.	Outturn per acre in lbs.
Infested seedlings	3	3,738	1,246
Healthy seedlings	5	6,555	1,311

Collection of the leaf cases is the only remedy which can be adopted in these parts. Draining out the water is impossible and impracticable. The *nga-htode-dalu*, figured at page 353 of the Proceedings of the Third Entomological Meeting, was on trial found to be of little use as the cases escaped through the long interspaces; besides, the heavy *dalu* seemed to break the young plants. A small hand net, made by sewing thin muslin or mosquito cloth to a triangular frame to form the mouth, and drawn with one side of the mouth just under the surface of the water proved to be the simplest and most effective instrument. A man can use two nets with two hands. A round mouth of the nets does but the triangular mouth sweeps a larger area with practically no injury to the plants. As the attack is usually in patches, large or small, such nets have since been used with the best effect.

Kerosene was tried, but the plots enclosed by mounds suffered from its effects. Its use in patches, which form parts of continuous sheets of water, is impracticable.

The use of kerosene has proved effective in Mysore. The method employed by the cultivators is to dip a cloth in kerosene and fasten it at the irrigation water inlet. A thin film of oil spreads over the whole of the surface of the water. No damages arises from the action of the kerosene upon the rice plant when this method is employed. Dr.

13.—A NOTE ON THE OCCURRENCE OF *CIRPHIS UNIPUNCTA* IN THE RÔLE OF "ARMY WORM."

By C. C. GHOSH, B.A., F.E.S., *Assistant Entomologist, Burma.*

Last year (1922) *Cirphis unipuncta* caterpillars appeared in large numbers and behaved as an "army worm" in the following places in three different districts, *viz.* :—

Meiktila District.—Mahlaing Farm ; two villages about three miles from this Farm ; a few villages in Wundwin Township.

Sagaing District.—Fields between Tada-U and Myinmu.

Magwe District.—Sale and a few villages about 8 miles from Sale.

In all these places their appearance was noticed at the same time, *viz.*, 5th or 6th October. At this time the caterpillars were grown and eating voraciously, thus attracting notice. The places are long distances apart. The year was characterized by a long period of drought followed by unexpectedly heavy late rains, a condition associated with the appearance of the "Army worm" in several other countries.

The crop attacked was *Andropogon sorghum* only. As is well known, the insect is recorded as a pest of paddy, maize, wheat, oats, millets, etc. But on this occasion paddy and maize, standing in the midst of the infested fields, were not at all touched. At one place the caterpillars seemed to have gone through a belt of maize to another field without eating the maize.

It could not be made out from where so many moths came all on a sudden. It appears they bred somewhere and the resultant moths took to wing and probably aided by wind (generally speaking blowing from South to North at the time) travelled long distances and settled here and there in batches. This view is supported by the simultaneous appearance of the caterpillars in patches many miles apart, although there was *Andropogon* present everywhere. An idea of the scattered nature of the attack may be formed from the areas infested in the different places visited, *viz.*, about 10 acres in the Mahlaing Farm, about 5 acres near Thedaw in Windwin Township and about one acre near Sale. In the Mahlaing Farm the attack was serious and all the 50 acres would have been destroyed but for the measures taken. The badly infested part, about six acres, was trenched, the trench being filled with water. Numerous caterpillars died in this trench. The grasses of the surrounding parts were cleared off so that the coolies could trample

and kill the moving hordes of caterpillars. Several tins full of caterpillars were collected from the fringes of uninfested parts to which the caterpillars were moving. Two, three or four caterpillars would be found hiding inside the rolls of leaves at the top of the plants where they were squeezed with the fingers and killed. Many caterpillars were shaken down and crushed on the ground. This work had to be continued for several days. The soil of the trenched area was found to be full of the red pupae ; therefore it was ploughed up on 13th October, laddered, harrowed and sown with maize. Near Thedaw no measures had been taken and on a visit about 15 days after the appearance of the caterpillars the pupae were found to be very much scattered and it was not easy to get at them. The infested plants had begun to put forth fresh leaves and it was clear that some sort of fodder would be obtained. No measures were taken in any of the other places infested. The moths began to emerge about the 16th October and there was no doubt that numerous moths emerged even at the Mahlaing Farm. If they had bred again the damage would have been simply terrible. But nowhere did a second attack occur. These caterpillars are recorded to damage ripening paddy by cutting off the ears. Such damage was apprehended but no report of any damage in this form has been received. The behaviour of the pest is therefore a mystery and would throw doubts on the after-treatment advocated, *viz.*, ploughing up of the infested fields. Prompt measures to " catch and kill " would seem to be the only thing to be depended upon.

14.—AN OUTBREAK OF *NEPHANTIS SERINOPA* AT MANGALORE IN 1922.

By RAO SAHIB Y. RAMACHANDRA RAO, M.A., F.E.S., *Acting Government Entomologist, Madras.*

(Plates 5—7.)

Mangalore is a fine and picturesque provincial town situated at the far northern end of the West Coast of Madras and, as the whole of the District of South Kanara is hedged in by the great chain of the Western Ghats on the east and by the ocean on the west, the town lies in a quiet seclusion which is broken only by the puff of the " Iron Horse."

The Coconut palm is the predominating feature of Mangalore and in fact to an on-looker from above, the town would appear to be covered by one vast sheet of coconut palms, which envelop all but a few of the taller buildings.

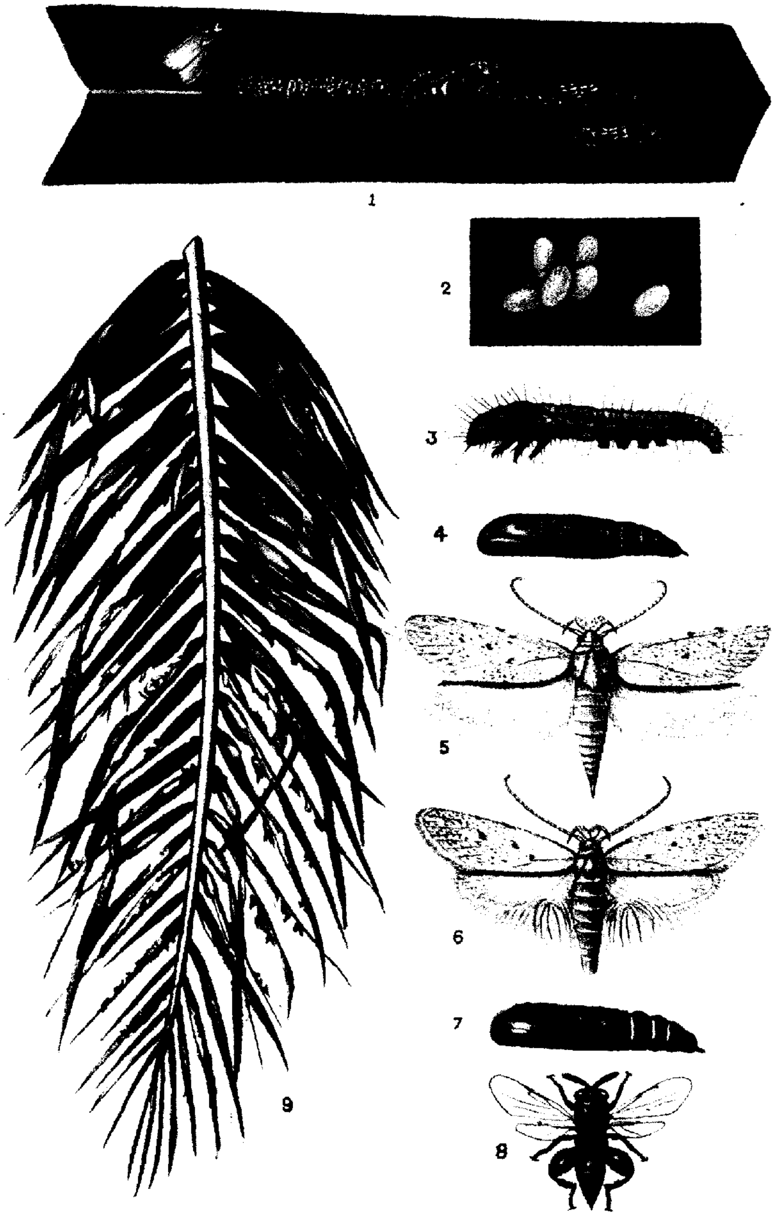
The tranquillity of the town was rudely broken one day in December 1921 when the citizens discovered to their chagrin the intrusion of an enemy in their midst. Numerous coconut trees in the neighbourhood of the Railway Station had become subject to a pest which was fast destroying them; and it was feared that at that rate the pest might increase and lay waste the whole of the coconut gardens of Kanara and bring ruin on the people.

The landholders of Mangalore thereupon sent up a Memorial to the Collector wherein the pest was described as " of the nature of a spider or moth swinging on its own thread from one tree to another and laying small and numerous eggs which turn out into as many caterpillars about an inch long with a hard head which eat the coconut leaves and hibernate in the rolled leaflets," and remedies were demanded. From the description of the pest it was evident that *Nephantis serinopa* was the cause of the damage and since no cheap and effective remedy was feasible, the petitioners were advised by the Agricultural Department to take instant measures for cutting down and destroying all infested leaflets so as to prevent a further spread of the pest. Although advice was given as early as the 28th January 1922, and although the local Revenue and Agricultural Officers advocated instant action, most of the citizens did not take any steps whatever towards that end, and, as a result thereof, the pest had time to multiply exceedingly and to spread from the original foci of infestation. On 1st July 1922 the *Mangalore Mail* (a local English weekly paper) wrote as follows : " As

EXPLANATION OF PLATE 5.

Nephantis serinopa.

.Leaflet showing galleries of the caterpillar, a cocoon and a moth.
2. Eggs (× 10).
3. Caterpillar (× 4).
4. Pupa (× 4).
5. Female moth (× 4).
6. Male moth (× 4).
7. Parasitized pupa (× 4).
8. *Chalcis*.(?) sp. (× 4).
9. An attacked frond.



NEPHANTIS SERINOPA.

one walks to-day by Attawar and Falneer, one invariably sees long lines of faded, spectre-like trees fully shorn of their green leaves, all standing there, thin, wasted and fast dying. Evidently these are coconut palms. But then, they present a pitiful, nay horrible appearance there; they seem to be plague-stricken all of them. A peculiar pest is eating them and destroying them wholesale..........This plague has assumed such proportions to-day that unless immediate measures are taken to exterminate it, there is no knowing what colossal havoc it might work in the future."

The citizens of Mangalore became by this time thoroughly awake to the seriousness of the situation and the necessity of immediate action and met together to concert measures to deal with the pest. They resolved to wire to the Government for help and, at the same time, formed a committee of influential citizens which was empowered to take all necessary steps for the control of the pest.

At a subsequent meeting, the committee, after considering the difficulties of influencing all garden-owners to consent to have their infested coconut fronds cut and burnt, resolved to apply through the Collector for the application of the Pest Act to bring round such people as were not amenable to argument. The Director of Agriculture, to whom the petition was sent, declared that he was not prepared to recommend the measure to the Government unless a request signed by all people concerned was received. He was moreover of the opinion that if possible the help of the Pest Act should not be invoked on every occasion and that in this case, since the pest was confined to a small area, the citizens should try to influence ignorant people and bring them round by the force of public opinion.

In the meanwhile the Agricultural Department placed at the disposal of the Committee for help in Pest control work the following officers:—Mr. J. A. Muliyil, Assistant to Government Entomologist, and two Sub-Assistants from the Government Entomologist's office, Mr. M. Mangesa Rao, Agricultural Demonstrator, and three Assistant Agricultural Demonstrators. The Acting Deputy Director of Agriculture, VII Circle, Mr. K. T. Alwa, arrived at Mangalore in August and, after conferring with the Committee, impressed on them the need of urgent action and the danger of delay. It was resolved to commence operations at once without waiting for the Pest Act, which might at any rate take a long time in coming, and to try the force of persuasion and public opinion to bring around people objecting to the remedial measures advocated. The committee divided itself into four groups with the object of holding meetings of *raiyats* in four different parts of Mangalore and explaining to them the necessity of immediate action.

About the second week of August operations were begun, a number of tappers were employed and divided into batches of two, each batch being under one of the Departmental officers mentioned above. One or two Revenue Inspectors were also kindly deputed for this work by the Collector for some time. The men were employed in cutting down all infested fronds from attacked trees and, as the attacked portions were better located from below, they were directed from below by the supervising officers. Attention was paid to prevent an indiscriminate cutting of diseased and healthy fronds alike, and as far as possible only such portions as were infested were removed. All cut leaves were collected by the other men and removed to a convenient corner and set fire to. The expenses were met partly from subscriptions collected by the committee from the citizens, and partly from the Collector's discretionary grant kindly diverted by the Collector, the late Mr. Nedungadi, for this purpose.

Work was hampered in the beginning by the heavy monsoon rains and later on by the lack of labour, but work was pushed on in spite of various impediments and the energetic way in which work was carried on reflects great credit on all the officers concerned in this difficult task. In most parts of the town, the owners of the garden did not hinder or obstruct work, but there were several who would not agree to have their trees treated. In such cases the supervising officers took the help of the committee, of influential citizens and of the Collector, for bringing their personal influence to bear on the parties concerned to get their assent, and in many cases with success, but there were some who would not be convinced, especially those living in the Moplah quarters of the town, whose chief objection was based on a possible violation of the *Ghosha* system.

In spite of these obstacles, the first round of clearing was finished in about a month and a half, 6,455 trees having been treated. Notwithstanding the first clearing, there remained certain cases of reinfestation (mostly from quarters where owners had refused to have their trees treated) and also certain cases where infestation had been overlooked on the leaflets, as the pest was probably in the initial stages of development. A second round was commenced and this time, wherever possible, affected leaflets were individually hooked out with a sharp knife tied to a long pole. This round took a somewhat longer time to finish; it was actually completed on 10th December as it proved to be, by its very nature, somewhat slow and difficult work and moreover some of the Agricultural officers had, by that time, been recalled for other work. Although the utmost was done by the Department to have the work carried out purely by means of persuasion, it was felt that owing

Nephantis **attack in various stages ; Mangalore, August 1922.**

to the perversity of some of the garden-owners the full attainment of the objects of this campaign would be frustrated, and it was feared that the pest would again begin to spread into cleared areas from such untreated centres. The Collector was therefore reluctantly obliged to request the Director of Agriculture to move the Government to sanction the enforcement of the Pest Act to coerce the minority who had proved refractory, to treat their trees so as to ensure the safety of the rest of the area.

The Government (Development Ministry) sanctioned the enforcement of the Pest Act at Mangalore and five miles around for one year from 1st January 1923, and the Pest Act is being now enforced, and it is hoped that it will soon help the people to exterminate the pest from Mangalore.

The Pest.—The pest concerned in the attack is *Nephantis serinopa*, Meyr., Fam. Xyloryctidae. The life-history of this moth has not yet been worked out in great detail in Madras, but a good amount of information is available on this point from work done in Ceylon recently. The moths are ashy-grey in colour and are flattish in shape and have the habit of resting flat on the under surface of the leaf or the bark of the stem so as to be quite inconspicuous. The male is smaller than the female and can also be distinguished in set specimens by the possession of a conspicuous tuft of hair at the base of the hind wing. The eggs are about 0·75 mm. long, elliptical, exhibiting a pearly sheen and faint reticulations. They are laid in batches of 3 to 10 or more on the lower surface of leaves or among the frass of the galleries made by the larvae. According to Dr. Hutson (*Tropical Agriculturist* LXI, 4th July 1922) " each moth can lay more than 350 eggs " in her life-time of two weeks. The eggs hatch in ten days. The larvae pupate in six to eight weeks, this stage lasting about two weeks. Although detailed life-history work has not yet been attempted here, it would appear that the duration of the various periods will prove to be much shorter in S. Kanara. For instance, the egg stage lasts only 4 to 5 days as against 10 days in Ceylon and the pupal period is only about ten days at Coimbatore and not two weeks. The caterpillar, soon after hatching, begins to feed on the green matter of the leaves and at the same time begins to construct around itself a silken tunnel in which pieces of chewed fibre and bits of excreta are incorporated. As the caterpillar feeds it extends its tunnels and as usually these caterpillars live somewhat gregariously the whole of the under surface of the leaf may be covered by their galleries. When large numbers are present, the leaf dries up and after a time, when sun and rain have had their play on it, becomes torn into shreds which ultimately drop off, so that in bad cases entire fronds are reduced

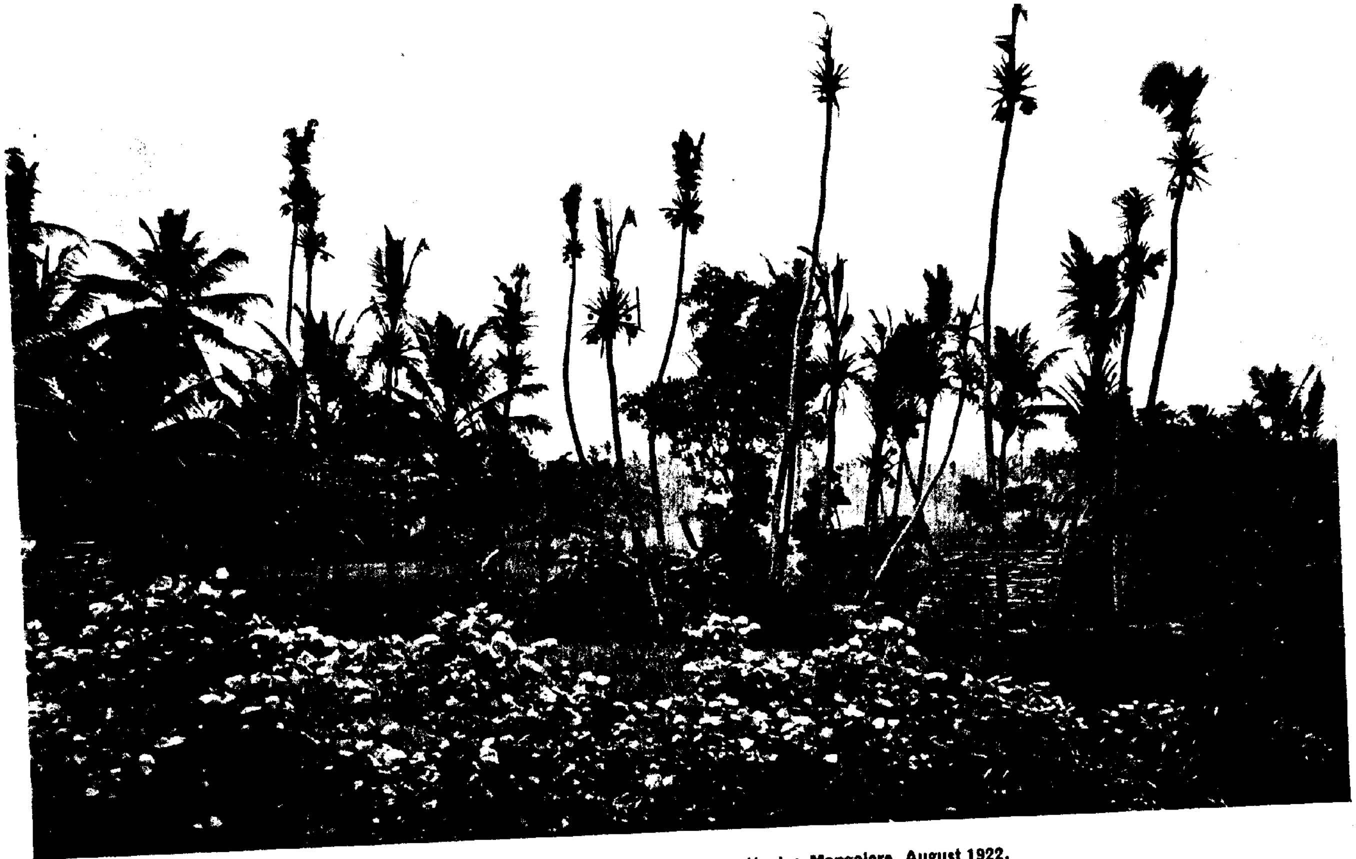
to mere skeletons. The mature caterpillar is about an inch in length, cylindrical and striped with longitudinal pinkish lines. The head and the prothoracic shield are reddish-brown while the meso-thoracic segment is dark brown so that on the whole the caterpillar presents a darkish appearance anteriorly, whence arises the popular name "Black-headed caterpillar." Pupation occurs in a tough oval cocoon built of silk and frass in a part of the galleries.

Food-plants and distribution.—At Mangalore, *Nephantis* was found on certain palms besides coconut, *viz.*, the Palmyra (*Borassus flabellifer*), the Talipot (*Corypha umbraculifera*) and the Sago palm (*Caryota urens*). It has not been noted either on Areca-nut or on the Date Palm. The pest has been reported from the following places in Madras as attacking coconut. Vizianagram (Vizag.), Tiruvannamalai (S. Arcot), Vellore (N. Arcot), Kottapadi (Tanjore Dt.), Masulipatam (Kistna), Madurantakam (Chingleput), Vaniambadi (N. Arcot), Baptala (Guntur), Salem Town (1922). In addition it has been observed attacking palmyra in the following places, although coconut palms in the neighbourhood were unaffected, Anamalai (Coimbatore Dt.), Kollengode (Malabar), Puduchatram (Salem Dt.), and Koilpatti (Tinnevelly Dt.). Outside Madras proper, the insect has been recorded from Cochin, Travancore, Bengal, Burma, Ceylon, and Indo-China.

As to its appearance in Mangalore it is evident that it has been unknowingly imported from outside. None of the older inhabitants of Mangalore had ever noticed such a pest and it was quite new to them. The fact that the pest had appeared first in the neighbourhood of the Railway station made one suspect that it must have made its entry by Railway. With the kind permission of the Railway authorities, Mr. Muliyil examined the parcel and goods records for the past two years and as a result the examination brought to light the fact that three consignments of coconut seedlings packed in baskets had been received by Goods train from Kayankulam (Travancore), the first one (14 baskets) booked on 22nd May 1921 and received on 3rd June 1921, the second one (13 baskets) booked on 22nd May 1921 miscarried to Salem and received by end of June 1921, and the third (8 baskets) delivered on 23rd December 1921. Since Kayankulam in Travancore is known to be infested, there is little doubt that the infestation at Mangalore originated from the consignments received in June 1921. This case is one of the many instances where modern facilities for fast locomotion have been productive of harm.

Natural enemies.—From the information available in the records at Coimbatore it would appear that this insect, though endemic in Southern India, assumes pest conditions only sporadically. Last year it was

PLATE 7



Coconut palms treated for *Nephantis* attack ; Mangalore, August 1922.

reported to be very serious in a garden at Salem, but an examination of the trees in September revealed the fact that, though there were numerous cases of infested leaves, there was not even one case of a live caterpillar. There were on the other hand evidences of parasitized pupae and parasitized caterpillars. It was evidently a case of a suppression of the pest by its parasites. Similar cases of this pest being kept in check by parasites were noted by Mr. K. S. Padmanabha Ayyar (formerly Entomological Assistant in this office) at Vaniambadi and Madurantakam.

Elasmus nephantidis, Gahan, is a black, yellow-spotted Chalcidid which attacks the pupa.* The parasitized pupa can be distinguished by certain blackish rings in the abdomen. When mature, the parasite bites a circular hole in the thoracic region of the pupa and emerges. This parasite was noted in small numbers in Mangalore and while cutting down and burning infested fronds, efforts were made to collect as many of the pupae as possible and rear the parasites in cages at the Laboratory and let out the parasites.

A Braconid? In addition to *Elasmus*, numerous small white cocoons (unfortunately all empty) were noted among the galleries found at Salem and N. Arcot. It is evident these are Braconids and attack the caterpillars themselves.

At Mangalore a small black Carabid grub was noticed by the writer to be predaceous on the caterpillars. Under observation in a tube it fed on three caterpillars and one pupa after which it pupated. The beetle emerged in five days and has been kindly identified by the Imperial Bureau as *Callida splendidula*, Fb.

Phlœodromius nigrolineatus, Chaud., is also recorded to be predaceous on *Nephantis* at Madras.

Remedial measures.—Although the caterpillar may be protected by its galleries it has always to move on to a fresh surface of the leaf for its food, hence a stomach poison like lead arsenate will prove to be effective in spite of the protection afforded by the galleries, but the conditions under which the spraying will have to be conducted are so arduous that the method becomes utterly impracticable. The height of the trees, the cost of the operation and the lack either of Power-sprayers as used in America or of an adequate supply of the small one-gallon pressure-sprayers, all united to make spraying out of the question. Light traps, although advocated in Ceylon, were found of no use at Mangalore, as no moths were attracted.

* The parasite shown on Plate 5 is not *Elasmus nephantidis*, as indicated on the Explanation of the Plate, but is apparently a species of *Chalcis*.—(*Editor.*)

Cutting out infested fronds and burning them was therefore the only practicable measure. Although people were afraid that treated trees might die, actually none of the trees in any of the private gardens in which they were in any way cared for, have died, in spite of the fact that 50 per cent. or more of the fronds had, in some cases, to be cut. The only place where deaths have been noticed is the Railway Station compound were most of the trees were not only very badly infested and had to be severely pruned, but had received no sort of care, either in the shape of irrigation or cultivation. The cost of the operation amounted to an expenditure of about Rs. 366-2-11 for 6,455 palms treated at the first clearing and worked out approximately at about 18 palms per rupee.

Instead of burning the leaves wholesale and thus destroying the parasites, the following method could have been followed. Large cages would have been constructed wherein all infested leaves might have been dumped, so that without allowing the moths to escape, the parasites might have been bred and let out so as to check such of the pest as had been left on the trees. As, however, large cages meant an additional expense and took much time for erection, the method could not be given a trial.

In conclusion, the writer wishes to place on record the energetic and willing work done by all the staff engaged in this task and especially by Mr. Mulivil who was directly connected with the control work from the beginning to the end. He contributed a good deal to the popularisation of these measures (and Entomological work in general) by delivering lantern lectures and speaking to the public on the subject of the pest and its control and also did much by the exercise of tact to bring round objectors. The writer believes that whatever measures of success has been achieved is due to the enthusiasm of the workers combined with the willing co-operation of some of the citizens. Whatever still remains to be done (and there is a great deal yet to be done) will, it is hoped, be accomplished by the enforcement of the Pest Act, and if, with its help, the pest be completely checked, as it is hoped it will be, the control of *Nephantis* will be one of those real accomplishments that will always stand to the credit of the Entomological Section.

15.—*ORYCTES RHINOCEROS* AND OTHER IMPORTANT PALM PESTS IN BURMA.

By C. C. Ghosh, B.A., F.E.S., *Assistant Entomologist, Burma.*

The coconut is grown throughout Burma, although its cultivation on a comparatively large scale is mostly confined to some of the sea-coast districts. The cultivation in many villages in the interior is by no means small. The crop obtained, however, is very much below the demand and coconuts of the value of about eight to ten *lakhs* of rupees are imported annually into the Province. There is ample scope for extending the cultivation and suitable lands are available all along the sea coast. But the cultivation, instead of extending, is fast decreasing, chiefly owing to the ravages of insects, of which the Rhinoceros Beetle or the Black coconut Beetle is no doubt the most important. What the effects of the activities of this beetle have been, can be partly gauged by the following facts. Messrs. MacKenna and Shroff recorded in 1911 that, prior to the appearance of this bettle in this province about 1895, the Maritime districts of the Tenasserim Division were said to be able to meet the local demand for coconuts ; but they were now very heavy importers from the Straits. An old resident of Thayetmyo informed the present writer that green coconuts, which could be had there for three quarters of an anna in 1891, were selling at eight annas in 1921. Nowhere in Burma at present can a green coconut be had for less than two annas, the average price being about four annas. The insect has been rapidly spreading into new districts from South to North, the whole of Lower Burma and a few adjoining districts in Upper Burma being at present affected.

Oryctes rhinoceros has not been working alone. *Xylotrupes gideon*, or Elephant Beetle, has been observed to be present throughout the Province although it has not hitherto been recorded from Burma. *Rhynchophorus ferrugineus*, or the Red Weevil, has apparently been following *Oryctes rhinoceros* and has not so far been met with in the region uninfested by the latter. *Nephantis serinopa* is also very important, especially in Upper Burma.

Oryctes rhinoceros.

As is well known, *Oryctes rhinoceros* flies at night and bores the tops of palm trees by gnawing a large hole at the base of the heartleaf or of one of the outer leaves. When the growing point or heart is damaged,

the tree ceases to grow and bear, gradually dwindles away and ultimately dies. Repeated attacks or subsequent attack of the Red Weevil and lodging of rain-water in the holes hasten the end. Frequently the beetle gnaws across the unfolded and unopened central leaves and such leaves on opening look to have been trimmed or punched.

Of the known food-plants of *O. rhinoceros* the following are present in Burma, *viz.*:—

(1) Coconut palm (*Cocos nucifera*) which is preferred to the rest;

(2) The palmyra palm or the toddy palm (*Borassus flabelliformis*) which is of great economic importance and is grown extensively in many districts, such as Magwe, Minbu, Pokokku, Myingyan, etc., for toddy and jaggery; its leaves are used for thatches and for making mats and a kind of box in extensive use in Burma; the stem yields a very strong timber and the fruits also are eaten both in young and ripe state;

(3) The *dhani* palm (*Nipa fruticans*), which is also of economic importance, its leaves being used for thatching purposes, and a drink is obtained from it; it is of a more wild nature than the above and grows in the form of thick bushes in damp places, especially along the banks of the numerous creeks in Lower Burma;

(4) The common wild date palm (*Phœnix sylvestris*) which is also of economic importance, as toddy and jaggery are obtained from the trees, the fruits are eaten and the leaves are used for mats and other purposes;

(5) The Talipot palm, Burmese *e-bin* (*Corypha umbraculifera*) which does not occur wild but is grown here and there in villages, apparently not for any particular purposes but as an ornamental plant;

(6) *Pinanga* palms of which three species occur, *viz.*, *P. gracilis*, Burmese *Taw-Kun*, in a wild state from Chittagong to Tenasserim; *P. hexasticha* in the Pegu Yoma (hill range), and *P. hymenospatha* in Moulmein;

(7) The Royal palm (*Oreodoxia regia*) which is grown in the horticultural gardens, Rangoon. The Betel-nut Palm (*Areca catechu*) is not attacked.

The principal and probably the only important breeding places in Burma are farmyard manure heaps, rotting paddy-straw heaps and dead palm (principally coconut) stems. The other two possible breeding places are the heaps of paddy husks near rice-mills and those of sawdust near saw-mills. But no breeding has been observed to take place in the mills the writer had the chance of examining. The paddy husks

are either burnt, or thrown into water or in some places used as manure in paddy fields. The saw-dust is also periodically cleared off. Both these substances take long to rot and as they are cleared before they have time to do so, they do not under the present conditions serve as breeding grounds.

Of the three breeding-places mentioned, farm yard manure heaps are the most important. All over the villages farm yard manure heaps are found, consisting chiefly of cattledung and paddy straw thrown out from cattlesheds and also of ashes, vegetable refuse and all sorts of rubbish commonly thrown on these heaps. Generally these heaps are contiguous to the cattlesheds. As they are seldom used as manure they lie in an undisturbed condition for long periods, in most cases until they get converted into earth. They may be added to at the top or edges. Practically all such heaps have been observed to be full of the young stages of the Rhinoceros Beetle throughout the year.

The paddy straw heaps form extensive breeding-places in the rainy season. No breeding takes place in straw as long as it is dry. The method practised in stacking or heaping straw renders it more suitable for breeding than it otherwise would be. The method of threshing paddy is to get the grains trodden out under the feet of cattle. The straw is thus broken and it is stacked in a loose condition by being heaped on the ground. On the top of the heap the rain-water does not get sufficient flow and therefore soaks down to a depth of about half to one foot. or even more, causing the entire top to rot. The base of the heap also soaks water and rots. Rotting paddy straw is the most attractive breeding-place and very much liked. Even very small heaps of this substance allowed to lie on the road-side are taken advantage of for this purpose.

The tops of dying trees have been observed to harbour beetles and grubs in company with the Red Weevil and its grubs. All dead stems are prolific breeding grounds.

The life-history and habits of the Rhinoceros Beetle were observed in the laboratory at Mandalay and in Yinnyein village in Thaton district. Fresh broods occur normally about every four or five months. Breeding is continuous and is going on throughout the year, the broods overlapping one another.

Arrangements are being made for controlling the pest by taking care of the breeding-places. It is proposed to have men who will go from village to village and see to the turning of the dung and rotten-straw heaps, removing of dead trees and stems, and taking other necessary steps. A preliminary trial in a village called Yinnyein in Thaton district gave hopeful results last year.

In order to educate the people the following publications are in the press :—

(1) A Bulletin detailing the results of the investigation carried on during the last two years.

(2) A popular pamphlet in English and Burmese to be liberally distributed.

(3) A large poster drawing pointed attention to the main facts in the life-history of the pest and in the necessary methods of control. It is proposed to distribute these posters throughout Burma and have them on view in all public places.

Xylotrupes gideon.

The damage to the coconut by this beetle takes the following form. The leaf-stalks are gnawed across or along their length to some extent, causing them frequently to break at the place attacked. The central unopened leaves are eaten or gnawed in the stalk, causing them to break very often or exhibit trimming and punching on opening. Although the leaf-stalks are in some cases bored down to the base, the beetles have not been observed to enter the stem. Therefore the trees are not killed as is done by the Rhinoceros Beetle. But the activities of the Elephant Beetle give a very ragged appearance to the trees. In some localities in Burma, where it occurs in large numbers and where the Rhinoceros Beetle has not yet been observed, for instance, Konzaung in the Mon canals area in Minbu district, the experience of the people is that these beetles attack coconuts only in the hot weather commencing from about March. At other times in the year they are found on other plants especially lady's fingers (*Hibiscus esculentus*) of which the pods are eaten. The writer found many beetles in November on this plant and also on wild *Cassia sophera*, of which they seemed to nibble the bark. In the laboratory they fed voraciously on lady's finger pods. They were also found feeding on bean leaves at Maymyo in September. Grubs were found under rotten straw heaps. This beetle is at present under observation. It apparently has a similar life-history to that of *Oryctes rhinoceros* and control measures directed against the latter will be applicable against it too.

Rhynchophorus ferrugineus.

This weevil is common in all the places where *O. rhinoceros* is present. In Burma it is known to occur on *Cocos nucifera*, the coconut palm, *Borassus flabelliformis*, the palmyra palm, *Corypha umbraculifera*, the

talipot palm, and *Phœnix acaulis*, a dwarf date palm called *thimboung-bim*. A brood reared only on coconut leaf-stalks in the laboratory took about four months in the latter part of the Rains and early winter. The only measure capable of being adopted is to remove the affected trees, which is one of the measures against *O. rhinoceros*.

Nephantis serinopa.

These caterpillars nibble the surfaces of the leaves. As a result of their feeding, the leaves dry. The attack commences from the lower leaves and gradually spreads to the upper ones. The pest is very active in the rainy season. In cases of bad infestation the trees are considerably weakened. The caterpillars however seldom prove fatal unless the attack is repeated in serious form year after year.

The pest passes its whole life on the plant. Eggs are laid on the leaves in crevices and furrows near the midrib. A single female lays about 200 eggs.

This is present in the whole of Burma and apparently in a worse form in Upper than in Lower Burma. It has been observed to attack the coconut, the palmyra, the betel nut, the wild date and the talipot palms, out of which the first two suffer the most. As the pest is present practically everywhere, even on small wild date palms in the waste lands and jungles, control measures become very difficult. Spraying with any kind of poison is out of the question. The only effective measure is to cut off and burn the first affected lower leaves. The importance of this measure will be apparent from the fact that a single infested coconut leaf has been observed to harbour up to about 700 caterpillars. The infested leaves therefore become prolific breeding grounds.

The writer's trials with ordinary and gasoline storm king lanterns in the Mandalay Farm at not very long distances from badly infested trees do not give much hope of success by means of light traps.

16.—AN INTERESTING PRINCIPLE IN ECONOMIC ENTOMOLOGY AND SOME SUGGESTED APPLICATIONS.

By K. KUNHI KANNAN, M.A., Ph.D., F.E.S., *Senior Assistant Entomologist, Mysore.*

In the course of my investigation of the serious pest of palms known as *Oryctes rhinoceros*, it was observed that a great proportion of the larvæ work their way several inches below the floor of the manure pit in which they thrive, for pupation. And it occurred to me that attempts should be made to prevent the return journey by the insects as adults. Now the larvæ and the adults are of about equal girth but, as the former are soft-bodied, they can sqeeze themselves through holes which are impassable for the rigid-bodied adult. A sheet of expended metal with meshes 12×24 mm. will let the larvæ through but not the adults and therefore should prevent the escape of beetles from manure pits in which the floor is covered over carefully by it. How far the idea will be of practical application in the control of the pest under the varying conditions in which the manure is stored remains to be seen; but this preliminary note is written to draw attention not to any remedy but to the principle itself, which is important and has wider application than to the insect from the study of which it was first derived. It has been found, for example, that it operates in flies also, where holes through which maggots may be able to pass are impassable by the adults. In the case of the house fly a perforated zinc sheet will let the maggots through but not the adults and a trap is under trial in which the flies are attracted to suitable material and the maggots resulting from oviposition have to pass for pupation through a perforated zinc sheet into a chamber from which the flies cannot escape. The success of this trap, as well as the lines of attack now opened up against *Oryctes rhinoceros*, remains to be seen but the principle is, I believe, of sufficient importance and of wide application for early attention to be drawn to it.

The idea suggested by Dr. Kunhi Kannan is not a new one. A similar suggestion has been tried in the case of the Codling Moth in America, where the attacked trees are banded with wire netting of such a mesh that the larvæ can enter inside to pupate on the trunk of the tree but the moths are unable to escape.

As regards *Oryctes*, I doubt whether the method, even if successful under control conditions, would be of much practical value in checking the beetle in its natural state. There is no difficulty in controlling it if proper precautions are taken in disposing of rubbish and general cleaning-up around palm groves.

17.—A NOTE ON *ANOMALA ANTIQUA.*

By C. C. Ghosh, B.A., F.E.S., *Assistant Entomologist, Burma.*

In the neighbourhood of Mandalay as well as in some other places in the Plains of Burma, both Upper and Lower, there are four or five species of Melolonthid and Rutelid beetles which have been observed in the course of the last two years to occur regularly. All have more or less a similar life-history. They are injurious both in the larval and adult stages. The grubs feed on the roots of crops like sugarcane, *Andropogon*, millets, and even groundnut, and frequently occur in large numbers in the fields. The adults are well-known as feeding on the leaves of many trees, including fruit trees, and also of field crops like *Sesamum*.

Anomala antiqua is typical of the others. The shiny blue-black beetles occur in swarms as a pest in July and August every year on *Sesamum* at Tatkon and eat the leaves. In August 1921 they occurred on *Hibiscus cannabinus* (*chimboung-bin*) on the Mandalay Farm. The opportunity was taken to study the life-history. In the laboratory eggs were freely laid in the third week of August 1921 in a glass trough filled with rotten cowdung and earth, about 500 eggs being obtained in the course of a week from a lot of about 50 beetles kept together. Fresh eggs were white and oval in shape measuring about 1·5 mm. one way and a little less in the other. They increased in size and changed shape with age, ultimately becoming almost round and about 2·5 mm. in diameter. They took 8 to 10 days to hatch. The grubs were fed in the laboratory with rotten cowdung, rotten paddy straw, and rotten leaves kept with earth. They became full-grown by the first week of October, moved down to the bottom of the glass trough containing them and formed cells in which they began to rest. Pupation took place between 3rd and 23rd March 1922, the pupal period lasting for about 12 to 14 days. The beetles, however, did not move out of the pupal cells soon after attaining the adult state and rested there for varying periods, the minimum period observed being five days. The beetles were now looked for in the fields but were not observed to swarm out before rain fell on the 24th April, when there was enough rain to moisten the earth. The next day *Holotrichia* and other species of *Anomala* (which also were under observation) were common at lights. *Anomala antiqua* was already known not to come to lights and, when looked for, was found in its favourite resorts, *viz.*, the rain trees (*Pithecolobium saman*, known as *Kokkobin* in Burma). These beetles have a special liking for this tree. In the evening they fly and hover around and among the

branches with a loud droning sound. Within about half an hour all becomes quiet. The beetles settle down and nibble flowers and tender leaves but only to a small extent, so that hardly any appreciable damage is done to the tree. Droughts and rainless periods followed when the beetles were not observed to fly. They invariably came out after rain fell and would be inactive when dry conditions prevailed. It was clear that general activity did not commence until the Monsoon set in. This is why the beetles are not reported to occur as a pest before about July and August. Mating however was observed whenever they swarmed. Therefore oviposition may take place early in the season if suitable conditions are available. Breeding on a general scale is apparently deferred till the setting in of the Monsoon. Grubs of this beetle have been so far collected and reared from among farm-yard manure heaps and roots of grasses and millets.

As noted above, this beetle appeared as a pest on *chinboung-bin* (*Hibiscus cannabinus*) on the Mandalay Farm in August 1921. There were two small plots about 0·5 acre each, side by side, of two varieties of this plant, one red and the other green. The beetles swarmed on both the varieties and fed by biting holes over the entire surfaces of the leaves, converting them literally into sieves. Outside the Farm, at a distance of about a mile from the above plots, there were some plants which were not affected. The reason was not clear.

The beetles appeared at dusk, flew about for about half an hour and then settled down on the plants. At this time they behaved gregariously. They sat clustering together, causing the plants to bend with their weight, and freely mated. High south winds blew at the time, shaking the plants rather violently. The beetles did not mind it.

Shaking the plants by drawing a thick rope over them after the beetles had settled, at about 8 P.M., had not much effect. One shaking dislodged very few. Five good shakings dislodged about 50 per cent.; but they would soon take wing and come back to the plants. Five shakings in this manner after short intervals, commenced at dusk, had a good effect, hardly any beetles being able to settle on the plants. Large numbers congregated on the neighbouring saccoline and other plants. At 10 P.M. they were still there and hardly any on *chinboung-bin*. The same effect was observed consecutively on three nights.

Half the plants in the green plot were sprayed on the 14th with kerosine emulsion, at 1 of the stock solution in 5 of water, the stock solution being prepared with—

Bar soap	8 ozs.
Water	8 pints.
Kerosine oil	16 „

None settled on the sprayed plants, while the unsprayed ones were full of them. The spray was then successfully applied on all the plants. By the 16th the kerosine smell disappeared from some of the plants sprayed first and some beetles were observed to come and settle on them. The spray therefore had to be applied again. As long as there was the smell of the kerosine present the beetles were kept off. The spray did no harm to the plants.

A strong gasoline lantern was set up at a short distance from the plants and worked for four nights while the beetles were being shaken off and kept off with kerosine emulsion. None was attracted to the light, although occasionally one or two beetles came to lights in houses.

Although thousands of the beetles appeared on the *chinboung* plants every night, search in the adjacent fields failed to trace more than a few hiding under the soil.

18.—SOME COCCINELLIDS OF SOUTH INDIA.

By T. V. SUBRAMANIAM, B.A., *Assistant to Government Entomologist, Madras.*

The Coccinellids, or Lady-birds, form a very important group of insects from an economic point of view, as they are predaceous insects mostly, and help to keep crop pests such as plant-lice and scales in check, and yet, unfortunately, they do not seem to have received adequate attention at the hands of Entomologists in India. Except for a few articles in publications like *Indian Museum Notes* and the Pusa Bulletins, no comprehensive study of the family as a whole seems to have been undertaken so far. In the following few pages an attempt has been made to bring together the scanty information that has been collected at Coimbatore regarding the South Indian forms. In this endeavour, the writer has been handicapped by want of literature on the subject to guide him, the little information that is available being mostly in French. The descriptions and life-history notes of the different species are his own, but free use has been made of the information available on the labels of the collection in the office of the Government Entomologist and in the office records so far as notes on distribution and feeding habit are concerned, and the writer trusts that the present paper will serve as a starting point for further work on the subject.

The family is an extremely important one from an economic point of view, for the great majority of the Coccinellidæ live as predators on certain soft-bodied insects that are harmful to crops. Among the latter are included the plant lice (Aphididæ) the scale insects and mealy bugs (Coccidæ) and the mealy wings (Aleyrodidæ). Some of them are known to feed on parasitic fungi. There is, however, one set of Coccinellids known as the *Epilachna* beetles, that are vegetable feeders, and these occur in large numbers as pests of crops. They scrape the green matter from the leaves of their food plants during their larval as well as their adult stage and may cause serious damage.

Members of this family are popularly known as Lady-bird Beetles, Lady Bugs or Lady Cows. The exact significance or origin of these names is not known. Perhaps it may be due to the pretty appearance of the insects. They are generally round and convex, sometimes circular, often oblong or oval in shape and range from a pin head to a little over ½ inch in diameter in size. The coloration is variable, specimens being often coloured red, black, orange, or yellow but the predominating

colour, especially in the most common species, is yellow with characteristic spots or lines. Some species are remarkable in exhibiting striking colour variations among its own members; *e.g.*, in *Chilomenes sexmaculata*, Fab., we have three kinds of individuals (*a*) those that are completely yellow or orange, (*b*) those that have one or two black wavy lines across the wings over the yellow colour, and (*c*) those that are completely black in colour, and all intermediate stages beginning from the first series and ending in the last are recorded. The beetles are not very active in flight and when disturbed fold their antennæ and legs against their body and fall down to the ground, feigning death. They are voracious feeders both during the larval and adult stages. Most of them also exhibit a cannibalistic tendency, eggs, larvæ and even fresh-emerged adults being eaten up by the neighbouring larvæ or adults.

The Coccinellids have a peculiar property of exuding a kind of liquid from their body when disturbed, like the blister beetles. This phenomenon is known as reflex bleeding and the liquid is a secretion from hypodermal glands and passes to the exterior from near the articulation between the femur and tibia. In an article on "Reflex Bleeding" of the Coccinellid beetle *Epilachna coxalis*, published in *Annals of the Entomological Society of America*, 1916, Mr. McIndoo says :—

"The liquid has an amber colour and a very offensive odour. It is almost as bitter as quinine and when tasted the bitter taste lingers in the mouth for almost half a day. It is slightly viscid and dissolves slowly in water." The same writer is of opinion that its chief purpose is that of protection but also probably aids the beetles in recognizing individuals of the same species.

The Coccinellids are easy to rear and the life-histories of some of them are well-known. It is generally very short, the whole life-cycle being completed in the course of three weeks. The beetles are very prolific in egglaying, one species having been noted to lay as many as 1,047 eggs. The eggs are generally laid in clusters on the surface of the plant. They are yellow, cigar-shaped and stand on end. The larvæ of the carnivorous species are generally black or slate-coloured and broader in the middle, tapering towards either end. There are spines or tubercles all over the body, topped by hairs. Those feeding on mealy bugs have waxy processes and so are not easily made out among their prey. The grubs of the *Epilachna* beetles are stouter and slightly yellow in colour. They are more thick-set and do not taper towards either end. They are also less active than the predaceous larvæ. In both cases they pupate openly on plants, the pupæ being attached by the tail end. The beetles, as soon as they emerge out of the pupæ, are soft and harden only in the course of a day and fly about. Hibernation takes place in the adult

stage in cold countries, but in South India there is no wintering. The predaceous beetles can be reared or collected and introduced into fields affected by plant-lice, Coccids, etc., to control these pests. The usefulness of these Lady Bird Beetles is reduced to a great extent by their liability to the attacks of certain Hymenopterous parasites. These, however, act as a check on such injurious forms as the *Epilachna* beetles.

The following are some of the common Lady Birds met with in South India. The knowledge about most of them is very meagre, but an attempt has been made to bring together all the available information on each species. Thanks are due to the Director, Imperial Bureau of Entomology, London, for his kindness in getting identified most of the species included in this paper.

1. *Coccinella septempunctata*, Fb.

References.

Plateau, *Ann. Ent. Soc. Belg.* XXXVI. 393.
Fletcher. *S. I. I.* 291.
Lefroy. *I. I. L.* 306.
Stebbing. *I. M. N.* VI. i. 50.
Tulgren. *Ent. Tijdschr.* XXXVII. page 94-98.

Life-history and habits.—These are found along with *Chilomenes sexmaculata* on cotton and other crops in the field that are infested by Aphids, but not in such large numbers as the latter.

The eggs are laid in clusters on the surface of the leaf, and are yellow and cigar-shaped. The larvæ are slate-coloured with scattered yellow patches and have long legs. They are active and feed voraciously The adults emerge from pupæ in three or four days.

Food.—Collected on Aphids on wheat, cotton, and *sorghum*, and reported to feed also on Aphids on mustard and blue-pine.

Distribution.—The Coimbatore collection contains specimens from Coimbatore, Dodabetta, Ootacamund, and Kotagiri, Bangalore, Bababuddin hills, and Chickbalapur (Mysore); Yercaud and Yeggasamudram (Salem District); and Teynampet (Madras).

2. *Coccinella transversalis*, Fb.

Reference.—*Coccinella repanda*, Lefroy, *I.I.L.*

Food.—These are found, along with *Chilomenes sexmaculata*, in cotton fields feeding freely on *Aphis gossypii*; they also feed on species of Aphids attacking wheat, *cholam* and water melon. Specimens have been recorded from leaves of brinjal and paddy.

Distribution.—Coimbatore; Chicacole (Ganjam), Podagatepalle and Samalkota (Godavari); Madras; Devankonda (Kurnool); Yemmiganur,

Hagari and Hadagalle (Bellary); Arabidacool Estate (Mysore); Madurantakum (Chingleput); Palur and Nellikuppam (South Arcot); Chittoor, Salem and Yercaud (Salem); Nilambur, Kanrikode, Chowghat and Cherukavu (Malabar).

3. *Coccinella 8-maculata*, Fb.

Food.—Beetles have been found feeding on Aphids on *sorghum*, paddy, melon and *ragi*.

Distribution.—Recorded from Coimbatore and Kumarapalayam (Coimbatore); Kurnul, Siddout (Cuddapah); Penukonda and Hindupur (Anantapur); Adoni, Siruguppa, Yemmiganaur, Beeravalli and Hagari (Bellary); Samalkota and Thanelanka (Godavari); Wandiwash (S. Arcot); Razolu (Kistna); Virudupatti and Koilpatti (Tinnevelly); Madras; Saidapet, and Madurantakam (Chingleput).

4. *Halysia cincta*, Fb.

References—

Thea cincta, Lefroy, *I. I. L.*, page 307.

Fletcher, *Bull. Ag. Res. Ins. Pusa No. 59*, page 14.

Life-history.—Eggs are laid in batches on the surface of the plant and are cigar-shaped, vertically attached, yellow in colour. The larva hatches out in 3 or 4 days and is light yellow in colour, with four longitudinal rows of black spots on the dorsal side, undersurface and legs whitish yellow, body flat and tapering towards the hind end. Pupa light yellow with two black oblique lines in front of the abdomen, diverging towards the hind portion. Adults emerge in 3 days.

Food.—The following is included in its dietary. Aphids on *cholam*, cotton, melon and brinjal; *Pulvinaria psidii* on *Morinda tinctoria*, *Perithecia* of the fungus on Mulberry leaves; on the fungus, *Oidium* sp., on *Pedulanthus*. Beetles have also been collected resting on the following plants, *Hibiscus esculentus*, Pumpkin, *Cosmos* flowers.

Distribution.—Coimbatore; Bangalore (Mysore); Nilgiris; Kurnul, Siddout (Cuddapah); Palur (S. Arcot); Hampi (Bellary); Koilpatti (Tinnevelly); Yercaud (Salem); and Kodaikanal (Palni Hills).

5. *Synonycha grandis*, Thunbg.

Reference.—*Indian Museum Notes*, Vol. VI, I, p. 52.

Food.—Specimens collected from bamboo, but feeding habits not known.

Distribution.—Bangalore (Mysore) and Coimbatore.

6. *Caria dilatata*, Fb.

One of the larger Coccinellids in S. India being only slightly smaller than *Synonycha grandis*.

Food.—The insect has been found to feed on Aphid, *Lachnus pyri*, on pear in the Shevaroy Hills and has also been collected on bamboo in Bangalore, but in the latter case the feeding habits are not recorded.

Distribution.—Bangalore (Mysore); Shevaroy hills (Salem); and Coimbatore.

7. *Alesia univittata*, Hope.

Food.—The insect has been noted to feed on Aphids on chillis. Mr. Ballard observed these beetles feeding on the inflorescence of paddy in the Samalkota Farm. Such habits are rather unusual in a predominantly predaceous group of insects and the observation requires confirmation.

Distribution.—Parlakimidi, Narayanavaram, Berhampore (Ganjam); Samalkota, Thanelanka and Razolu (Godavari); Saidapet (Chingleput); and Coimbatore.

8. *Alesia discolor*, Fb.

Distribution.—Taliparamba (Malabar).

9. *Verania quadrimaculata*, Ws.

Food.—Beetles have been collected from Sugarcane; probably they feed on Aleyrodids or mealy-bugs on this crop.

Distribution.—Taliparamba (Malabar).

10. *Synia melanaria*, Muls.

Food.—Collected from the following plants but no record as to what they feed on, *agathi*, *lablab*, *Trewia*, *Butea*, and snakegourd.

Distribution.—Parli (Malabar); Coimbatore; and Kallar (Nilgiri hills).

11. *Coelophora cardoni*, Weis.

References—

Bull. Ent. Soc. Belg. 1892, page 19.

Bull. Ent. Soc. Belg. 1894, page 202.

Bull. Ent. Soc. Belg. 1895, page 153.

Food.—Beetles have been recorded feeding on green mealy-scale on coffee shade trees.

Distribution.—Shevaroys (Salem); Mangalore (South Kanara); Bangalore (Mysore); Erode (Coimbatore); and Manganallur (Tanjore).

12. *Coelophora bissellata*, Muls.

Reference—Sicard, *Ann. Soc. Ent. France*, LXXIX, page 381.

Food and distribution.—Nothing is known about this insect except that it is found on the Nilgiri hills.

13. *Coelophora circumusta*, Muls.

Food.—Insects have been collected from mango leaves and *cholam*, their food not recorded.

Distribution.—Coimbatore ; Dharakota (Vizagapatam) ; Chintalapudi (Kistna).

14. *Chilomenes sexmaculata*, F.

References—

Lefroy, *I. I. L.*, p. 307.
I. M. N. Vol. III, V, p. 55.
I. M. N. Vol. VI, I, pp. 45 and 53.

Coccinella 6-maculata, Fabr., *Sp. Ins.*, I. 96-20 (1781).

Chilomenes 6-maculata, Muls., *Spec.*, p. 444.

The most numerous and most widely distributed Coccinellid beetle in South India. There are a number of variations in colour among the individuals of the species. Three distinct types can be made out with all sorts of intermediate forms.

Type I.—Head yellow, antennæ orange, eyes black, prothorax yellow, anterior edge stopping away behind the eyes, only the lateral flaps projecting beyond, a black anchor-shaped mark in the middle bordering on the posterior end, elytra yellow, slightly orange in some cases with two zig-zag cross lines in the middle and a black dot towards the apex of each wing case, a median longitudinal black line along the suture beginning from the anchor-shaped mark on the prothorax and extending to the end of the elytra. Underside of the body and legs orange yellow.

Type II.—The same as No. I with no black marks on the elytra except the line along the median suture.

Type III.—Same as type I with the elytra entirely shining black, only the lateral edges of the prothorax having a yellow tinge.

These three types freely mate with one another and the intermediate forms are also found in the field. There was some doubt about the identity of the species in all these three cases but it has recently been cleared.

Life-history and habits.—The beetles are found in large numbers wherever there are plenty of Aphids and are seen pairing in the fields. The larvæ and the adults exhibit cannibalistic tendencies and have been noted to feed on eggs and larvæ when there is scarcity of food. The beetle is also able to tide over unfavourable conditions by resting as adults. No difference is noticeable between the different types in the egg or larval stages. Males and females are not easily distinguished except by their size, the female being bigger than the male.

Eggs are laid in batches of 10 or 15 on the surface of the plant on which Aphids are found and are yellow and cigar-shaped and stand on end. They hatch in two or three days. Larvæ are black grubs with spines all over the body, remain near the egg-shell for a few hours after hatching, feed voraciously on Aphids, moult three times and take about 10—12 days to mature: attach themselves to the support by their hind ends and turn into naked pupæ. The latter are yellowish or blackish and take 3 or 4 days for the adults to emerge.

Food.—Aphids on cotton, brinjals, *Calotropis*, *cholam*, *ragi*, orange, paddy, *lablab*, tobacco, indigo, and wheat; Scales on redgram, coffee shade trees (?), guava, coconut, and paddy; Mealy-wings on cane and castor; *Pulvinaria psidii* on *Morinda tinctoria;* species of *wood louse* on castor.

Distribution.—Practically throughout South India.

15 *Chilocorus nigritus*, F.

References—

T. V. R. Ayyar, some Coccidæ of S. India (*Pusa. Bulletin 87 of 1919*).

Ann. Soc. Ent. Belgique, XLV, page 92.

Food.—Green mealy-scale on shade trees of coffee, scales on coconut, *Pulvinaria psidii* on *Morinda tinctoria*, *Pulvinaria maxima* on *nim* trees. It is said to be a predator on *Hemichionaspis minor*. Specimens from mango leaves, bamboo, *Cassia corymbosa* pods, castor, *Cactus* and brinjal occur in the collection but without any food records.

Distribution.—Coimbatore; Courtallam (Tinnevelly); Salem, Shevaroys (Salem); Vanayampadi (Salem); Bangalore; Madurantakam (Chingleput); Tirukkovilur and Molagakuppam (South Arcot); Kurumbranad and Mahe (Malabar); Parlakimedi, Narayanavaram Ganjam); Hospet and Bellahunsi (Bellary); Anakapalle (Vizagapatam); Manaparai (Trichinopoly).

16. *Chilocorus circumdatus*, Schonherr.

References—

E. E. Green, *Coccidæ of Ceylon*, p. 112.

T. V. R. Ayyar, Coccidæ of S. India (*Pusa Bulletin No. 87 of 1919.*)

Food and distribution.—There are only two specimens in the collection, both collected from Hillgrove on the Nilgiris feeding on *Lecanium viride*. It is reported to be an enemy of *Hemichionaspis aspidistræ* and *H. minor* in Ceylon.

17. *Stictobura pallideguttata*, Muls.

Food.—*Lecanium viride.*

Distribution.—Hillgrove and Coonoor in the Nilgiris.

18. *Clanis soror*, We.

Food.—*Aleyrodes ricini* on castor.

Distribution.—Coimbatore.

19. *Clanis pubescens*, F.

Food.—*Pulvinaria maxima* on *nīm* trees.

Distribution.—Coimbatore and Palni hills.

20. *Brumus suturalis*. F.

Life-history and habits.—The larvæ and the adults are found living on the egg-masses of scales and mealy-bugs. The larvæ are slate-coloured and covered by white powdery meal over their body ; they have a wrinkled appearance and are stout and tapering towards either extremity. They pupate under the scales and among their egg-masses, the pupa being stout and short. The exact period of life-cycle is not known.

Food.—Both larvæ and adults feed on (1) *Phœnacoccus insolitus* on *Triumphetta*, *Achyranthes aspera*, *Tribulus terrestris*, *Abutilon indicum* and *Sida* sp., (2) Aphids on *cholam*, cotton, and melons, (3) scales on redgram, and (4) castor Aleyrodid.

Distribution.—Coimbatore : Yercaud (Salem) ; Siddout (Cuddapah) ; Samalkota (Godavari) ; Koilpatti and Tuticorin (Tinnevelly) ; Mundakayam (Travancore) ; and Calicut (Malabar.)

21. *Novius roseipennis*. Muls.

Food.—Feeds on a species of *Monophlebus* on *Erythrina*.

Distribution.—Coimbatore ; Shevaroys (Salem) ; Taliparamba (Malabar) ; Parlakimidi, Narayanapura (Ganjam) ; and Tirukoilur (S. Arcot).

22. *Novius guerini*, Crotch.

Distribution.—Palni hills (3,500 ft.)

23. *Scymnus xerampelinus*, Muls.

Food.—*Phænacoccus insolitus* on brinjal.
Distribution.—Coimbatore.

24. *Scymnus luridus*, Muls.

Distribution.—Vellore Cantt. in North Arcot.

25. *Scymnus guimeti*, Muls.

Food.—Beetles have been collected from betel vine but it is not known what exactly they feed on.
Distribution.—Coimbatore; and Yercaud (Salem).

26. *Scymnus nubilus*. (?)

Food.—Adults collected from *cholam* earheads and *ragi*.
Distribution.—Coimbatore; Kodaikanal; Manganallur (Tanjore).

27. *Scymnus sp.*

Life-history.—The beetle breeds in the egg masses of *Nîm* scales (*Pulvinaria maxima*); larvæ and adults are found among the egg-masses. Larvæ are small and covered with white mealy covering.

Food.—Egg-masses of *Pulvinaria psidii* on guava, mealy-bugs on figs, mealy-bugs on *Datura* and egg-masses of *Pulvinaria maxima* on *Nîm*.

NOTE.—A few beetles have been recorded from custard apple and inside some galls but without food notes.

Distribution.—Coimbatore.

NOTE. There is a figure of this in Mr. T. V. Ramakrishna Ayyar's Bulletin on some South Indian Coccidæ in the plate giving the life-history of *Pulvinaria maxima*.

28. *Scymnus sp.*

Food.—*Ripersia sacchari* on paddy.
Distribution.—Negapatam (Tanjore).

29. *Scymnus sp.*

Food.—Egg-masses of *Phænacoccus insolitus* on *Tribulus terrestris*, *Abutilon* sp., *Achyranthes aspera*, *Sida* sp., *Pseudococcus virgatus* on custard apple; *Pseudo coccuscorymbatus* on cotton, *Pulvinaria maxima*

on *Nîm*, *Pulvinaria psidii* on guava, mealy-bug on *Capparis sepiaria* and *Datura*, Aphids on *cholam*, cotton and brinjals.

Distribution.—Coimbatore.

30. *Epilachna dodecastigma*, Muls.

References—

Lefroy, *I. I. L.*
Fletcher, *S. I. I.*, page 292.
I. M. N., Vol. II, part 6, page 154.

Life-history.—Yellowish cigar-shaped eggs are laid in groups, standing on end on the leaves of the food plant. From these stout yellow grubs covered all over with stout branching spines emerge which scrape out the green matter from the leaves in characteristic patches. When full grown they are about 10 mm. long and attach themselves by their hind end and pupate openly on the leaves or stem. The pupæ are squat and yellow in colour. Both the larvæ and the adults feed on the leaves and are thus harmful. The larvæ are parasitized by the grub of *Pleurotropis* sp.

Food.—A number of solanaceous plants such as *Solanum nigrum*, brinjals, *Datura*—A number of cucurbitaceous plants such as bitter gourd, *Momordica*, and Pumpkin, rarely *cholam*.

Distribution.—Coimbatore: Taliparamba, Ernad, Parli and Santhanathode (Malabar); Erode, Komarapalayam, and Anamalais (Coimbatore); Yercaud (Salem); Saidapet (Chingleput); Palur, Mulagakuppam and Sethambadi (S. Arcot); Bhumanagadda (Chittoor); Swamimalai (Tanjore); Mercara (Coorg); Kodaikanal; Wandse (S. Kanara); Samalkota (Godavari); Pirmad (Travancore).

31. *Epilachna vigintioctopunctata*, Fabr.

References—

Lefroy, *I. I. L.*
Fletcher, *S. I. I.*, page 292.
Agric. Gazette New South Wales, 1891, pages 281-283.
Ann. Soc. Ento. Belgique, 1885.

Life-history.—Same as *E. dodecastigma*. Invariably the two are found together, though this is more common than the other.

Food plants.—Similar to those of *E. dodecastigma*.

Distribution.—Coimbatore, Komarapalayam, and Erode (Coimbatore); Pithapuram (Godavari); Munagala (Kistna); Derbail, Mangalore and Kasargode (South Kanara); Hagari and Beeravalli (Bellary); Koilpatti

(Tinnevelly); Swamimalai (Tanjore); Palur and Sethambadi (S. Arcot); Saidapet (Chingleput); Yercaud and Hosur (Salem); Mulagakuppam (Chittoor); Pattikonda (Kurnool); Parli, Taliparamba, and Ponani (Malabar); Bangalore (Mysore); and Kottayam (Travancore.)

32. *Epilachna delesserti*, Gubr.

Distribution.—This is probably a Hill species. The Coimbatore collection contains specimens collected from Coimbatore, Kodaikanal. Naduvattam, Coonoor, and Ootacamund, and Bababuddin hills (Mysore.)

33. *Epilachna pytho*, Muls.

Distribution.—Taliparamba (Malabar.)

34. *Epilachna bis-4-punctata*, Goeb.

Reference.—Sicard. *t. c.*, page 496.

Distribution.—Samalkota (Godavari); Palur (S. Arcot); and Manganallur (Tanjore.)

35. *Epilachna ocellata.* (?)

Distribution.—Sidapur (Coorg); and Thanelenka (Godavari).

36. *Epilachna doryca*, Bois.

Distribution.—Kodaikanal.

37. *Epilachna indica*, Muls.

Distribution.—Taliparamba (Malabar.)

19.—A PRELIMINARY LIST OF PARASITES OF ECONOMIC IMPORTANCE BRED IN THE PUNJAB.

By M. AFZAL HUSAIN, M. Sc. (PUNJAB), M.A. (CANTAB.), I.A.S., *Entomologist to Government, Punjab, and* UMRAO BAHADUR MATHUR, L.AG., *Agricultural Assistant, Punjab Agricultural College.*

It was in 1919 that work on the parasites of pests in general and on Bollworm parasites in particular was taken up systematically. Specimens reared were sent to the Imperial Bureau of Entomology, London, for identification.

The following list gives the names of a very small number of parasites of this great Province. Our last instalment of over 50 species of parasites forwarded to the Imperial Bureau of Entomology, has not yet been received back. As time goes on, we hope to add to this list.

In the attached table the stages in which the various hosts are attacked, are given after the name of the host.

E. stands for eggs.
L. stands for larvae.
P. stands for pupae.

A Preliminary list of Parasites bred out from various Crop Pests of the Punjab.

Serial No.	Name of the Parasite.	Group or family of the parasite.	Name of the host and the stage attacked.	Family of the host.	Distribution in the Punjab.	Specimens identified by.
	Hymenoptera.					
1	*Fileanta rufocauda*, Cam.	Ichneumonidae	*Agrotis* sp., L.	Noctuidae	Lyallpur	1. Uvarov.
2	*Amblyteles* sp.	Do.	Do.	Do.	Do.	2. Do.
3	*Melcha nursei*, Cam.	Do.	*Earias insulana*, P.	Do.	Do. Sargodha, Lahore, Jullundur and Hansi.	3. Waterston.
4	*Atractodes* sp.	Do.	*Athalia proxima*, P.	Tenthredinidae	Lyallpur	4. Uvarov.
5	*Do.*	Do.	*Heliothis obsoleta*, L.	Noctuidae	Do.	5. Do.
6	*Vipio* sp.	Braconidae	*Sphenoptera gossypii*, L.	Buprestidae	Hansi	6. Waterston.
7	*Glyptomorpha deesae*, Cam.	Do.	*Chilo* sp. L.	Pyralidae	Lyallpur, Ferozepur	7. Uvarov.
8	*Bracon (Microbracon) lefroyi*, D. and G.	Do.	*Earias insulana*, L.	Noctuidae	Nearly throughout the Province.	8. Waterston.
9	*B (Habrobracon) kitcheneri*, D. and G.	Do.	Do.	Do.	Lyallpur	9. Do.
			Phycita infusella, L.	Pyralidae	Do. Montgomery, Rohtak.	Do.
			Nephopteryx sp., L.	Do.	Lyallpur	Uvarov.
10	*Bracon* sp.	Do.	*Bruchus rectabilis*	Mylabridae (Bruchidae).	Do.	10. Waterston.
			Amblyrrhinus poricollis	Do.		
			Caryoborus gonagra	Do.		
11	*Do.*	Do.	*Vanessa cardui*, L.	Nymphalidae	Do.	11. Do.
12	*Hormiinae*	Do.	*Chilo*, sp., P.	Pyralidae	Do.	12. Uvarov.
13	*Rhogas testaceus*, Grav., var.	Do.	*Earias insulana*, L.	Noctuidae	Nearly throughout the Province.	13. Waterston.

14	*Chelonus* sp.	Do.	*Do.* *do.*	Do.	Lyallpur	14. Do.
			Laphygma exigua, L. ?	Do.	Mona (Sargodha)	
			Tarache sp., L.	Do.	Hansi	
			Phycita infusella, P.	Pyralidae	Lyallpur	
15	*Ascogaster* sp	Do.	*Laphygma exigua*, L.	Noctuidae	Mona (Sargodha)	15. Uvarov.
16	*Apanteles* sp.	Do.	Tineids on cotton, L.	Tineidae	Sargodha, Hansi	16. Waterston.
17	*Do.*	Do.	*Euproctis lunata* ? L.	Lymantriadae	Lyallpur, Jullundur	17. Do.
18	*Microplitis* sp.	Do.	*Heliothis obsoleta*, L.	Noctuidae	Do.	18. Uvarov.
			Agrotis sp., L.	Do.	Do.	
			Laphygma exigua, L.	Do.	Do. Mona	
19	*Chalcis tachardiae*, Cam.	Chalcididae	*Earias insulana*, P.	Do.	Do. Hansi, Rohtak.	19. Waterston.
20	*Do. responsator*, Walk.	Do.	*Do.*	Do.	Hansi	20. Do.
21	*Do. rufescens*, Cam.	Do.	*Phycita infusella*, P.	Pyralidae	Lyallpur	21. Do.
22	*Do.* sp.	Do.	*Earias insulana*, P.	Noctuidae	Do.	22. Do.
23	*Euchalcis* sp.	Do.	*Phycita infusella*, P.	Pyralidae	Do.	23. Do.
24	*Centrochalcis* sp.	Do.	*Earias insulana*, P.	Noctuidae	Do.	24. Do.
25	*Elasmus* sp.	Elasmidae	*Do.* *do.* L.	Do.	Do. Satgodha, Rohtak Hansi.	25. Do.
26	Do.	Do.	*Hypsopygia mauritialis*	Pyralidae	Lyallpur	26. Do.
27	*Tetrastichus radiatus*, Wstn.	Eulophidae	*Euphalerus citri*, L.	Psyllidae	Do. Sargodha, Gujranwala.	27. Do.
28	*Trichogramma evanescens*, Westw.	Trichogrammatidae	*Earias insulana*, E.	Noctuidae.	Lyallpur	28. Do.
	Diptera.					
29	*Actia aegyptia*, Vill	Tachinidae.	*Do.* *do.* L.	Do.	Do. Lahore, Sialkot, Jullundur, Bhatinda, Hansi.	29. Villeneuve.
			Laphygma exigua, L.	Do.	Mona (Sargodha)	
30	*Euproctimyia pyrrhaspis*, Vill.	Do.	*Euproctis* sp., P.	Lymantriadae	Jullundur, Lyallpur, Lahore.	30. Do.
31	*Blepharipoda lucagus*, Wlk.	Do.	*Creatonotus gangis*, L.	Arctiidae	Lyallpur	31. Bryant.

20.—THE LIFE-HISTORY OF *TETRASTICHUS RADIATUS*, PARASITIC ON *EUPHALERUS CITRI*, KUW; AND ITS HYPERPARASITE.

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Introduction.—During the course of investigation of *Euphalerus citri*, a serious pest of citrus plants in the Punjab, it was found that the nymphs of this pest were very highly parasitized during certain parts of the year. This pest has so far been effectively controlled by spraying, but this operation is destructive alike for the pest and the parasite, and in order to save the beneficial insect from harmful results of spraying it was necessary to study the life-history and bionomics of the parasites of the Citrus Psylla.

During our observations we have been able to rear six different species of parasites from *Euphalerus citri*. The most abundant of these is *Tetrastichus radiatus* (Family *Eulophidae*, Westw., of the *Chalcidoidea*) which has been described, from the material sent by us, by Waterston (*Bulletin of Entomological Research*, May 1922).

Other species of these parasites have been sent to England for identification. The pupae and grubs of *T. radiatus* are attacked by a hyperparasite (not yet identified). The life-history of *T. radiatus* and its hyperparasite is given in the following pages.

Life-history of Euphalerus citri.—The eggs of *E. citri* are laid in the axil of leaves and the nymphs and adults spend their life sucking the juice from young leaves. The eggstage and the nymphal stages are passed through considerably faster in the hot than in the cold weather. The nymphal life varies from 11 to 13 days in summer to 34 to 36 days in winter. The complete life-cycle (egg to adult) occupies 16 days in summer and 46 days in winter. The average number of eggs laid by a female may be taken at 22, but the highest so far recorded has been 800.

Parasitized nymphs.—It is difficult to distinguish the parasitized nymphs from those unparasitized. They are not paralyzed by the parasite before or at the time of oviposition. The nymphs with egg or even grub of the parasite have been found feeding for a sufficiently long time and succumbing only when the greater part of the contents of the body had been sucked.

Oviposition.—The female parasite moves actively on the leaves amongst the nymphs of the Psylla striking them with its antennae as if searching for a suitable host. After selecting a proper host the parasite sits quietly by the side of the nymph, bends its abdomen under and thrusts out the ovipositor, and lays an egg on the underside of the nymph. This operation occupies about 3 or 4 minutes. In all cases the egg has been observed on the ventral side of the nymph just near the hindermost legs on the left or the right side. The egg is partly hidden by the coxae of the legs, having been laid in the grove of the first abdominal segment. The nymph is slowly sucked out by the grub and therefore the nymphs that bear parasites on them continue to live, feed, secrete waxy and juicy secretion for some time. When the grub is full grown and all the contents of the nymph have been consumed, the colour of the nymph changes from orange to dark brown, and the grub uses the dead body of its host as covering. The sides of the nymphal remains are attached to the leaf by means of silken threads produced by the grub. It is by means of these silken threads and the colour of the nymph that a parasite-bearing nymph can be distinguished. In some cases the body of the parasitized nymph is not swollen.

The position of the parasite in the body of the host.—The grub sucks the nymph from its ventral side and therefore its own dorsal side is touching the leaf, *i.e.*, the ventral sides of the parasite and the host are close together. The grub pupates in the same position; its head might point towards the head of the host or towards its posterior end.

Emergence from the Host.—The parasite makes its way out after biting a round hole in its covering forming the nymphal exo-skeleton in the region of the thorax or abdomen. A nymph provides food and space just enough for one parasite and in all cases so far observed only one grub has been found on one host and only one parasite has emerged from each attacked nymph.

Different species and percentage of parasitization.—Collection of nymphs was made from different Citrus gardens at Lyallpur, Sargodha and Gujranwala, and these were kept under observations so as to determine the percentage of parasitization.

Year 1921.

Month of Collection.	Locality.	Number of nymphs examined.	Number of parasitized nymphs.	Percentage of Parasitization.	REMARKS.
May	Lyallpur	575	*Nil*	*Nil*	No parasite.
	Gujranwala	No Collection.			
June	Lyallpur	1,320	...	...	No parasite.
	Gujranwala	1,910	...	...	
July	Lyallpur	930	562	60	
	Gujranwala	78	33	42	
August	Lyallpur	535	299	56	
	Gujranwala	92	72	78	
September	Lyallpur	126	92	75	
	Gujranwala	65	62	95	
October	Lyallpur	64	45	70	
	Gujranwala	...	...	...	
November	Lyallpur	99	86	86·5	
	Gujranwala	..	...	...	
December	Lyallpur	5	3	60	
	Gujranwala	...	...	...	

Year 1922.

Month of Collection.	Locality.	Number of nymphs examined.	Number of nymphs parasitized.	Percentage of Parasitization.	REMARKS.
January	Lyallpur	104	91	87	
	Gujranwala	138	129	94	
February—June	..	No Collection could be made.			
July	Lyallpur	455	..	...	
	Gujranwala	325	...	...	
	Sargodha	405	13	3·2	
August	Lyallpur	767	41	5·3	
	Gujranwala	442	23	5·2	
	Sargodha	335	9	2·6	
September	Lyallpur	1,219	664	54·4	
	Gujranwala	..	...	...	Heavy rain.
	Sargodha	..	...	...	No nymph.

Year 1922—contd.

Month of Collection.	Locality.	Number of nymphs examined.	Number of nymphs parasitized.	Percentage of Parasitization.	REMARKS.
October	Lyallpur	511	215	42	
	Gujranwala	...	...	...	
	Sargodha	...	...	...	No nymphs.
November	Lyallpur	622	588	89	Parasitized.
	Gujranwala	74	64	86	
	Sargodha	210	151	72	
December	Lyallpur	1,524	1,280	94	Average of 13 gardens, highest was 92 per cent.
	Gujranwala	265	165	62	
	Sargodha	655	537	82	
January 1923	Lyallpur	410	368	87	A large number of adults observed in gardens.
	Gujranwala	29	15	51	Very young nymphs.

Although a great percentage of the nymphs are actually parasitized most of the parasites cannot develop. A large number of parasitic grubs and pupae were found dead when the fixed host was turned over and examined.

Table showing the number of nymphs parasitized and percentage of parasites that actually emerged out.

Month.	Number of nymphs parasitized.	Number of parasites emerged out.	Percentage of emerged parasites.
November 1922	90	30	33·3
December 1922	1,250	649	51·9
January 1923	358	130	36·3

Presence of Hyperparasites.—Grubs and pupae of the hyperparasites were observed on *T. radiatus* grubs and pupae, but these were very few in number. It was mostly at Lyallpur from a Citrus hedge in the college

compound that hyperparasites were observed. The following figures show the proportion of hyperparasites.

Number of nymphs	Number of parasitized nymphs.	Number of hyperparasites.
1,524	1,250	26
202	174	4

Out of the (515) total number of the parasites the proportion of different species is given in the following table got from different gardens at Lyallpur. *Tatrastichus radiatus* was observed in largest numbers.

Month of Collection.	Name of garden.	Species of Parasites.						
		E_1	E_2	E_3	E_4	E_5	E_6	TOTAL.
December 1922 .	College compound .	96	51	30	33	2	2	214
	Botanical garden .	15	10	1	4	...	...	30
January 1923 .	Gol Bagh . .	30	12	12	3	1	1	59
	College compound .	80	72	10	22	...	1	185
	Botanical garden .	18	7	1	1	...	...	27
TOTAL .	...	239	152	54	63	3	4	515
	E_1 = *T. radiatus.*							

The data as yet obtained are far too few for us to be able to correlate the occurrence and subsidence of outbreaks of *E. citri* with parasite conditions. During the hot weather the pest is in more abundance and the parasites have not been observed. From the figures it is clear that the percentage of parasitization was highest during December 1922 and January 1923 but during that time Psylla has not been very bad. The most active period for Citrus Psylla, and when the trees are susceptible of deep injury, is from middle of February to the middle of April.

Length of life of parasites.—For parasites kept in tubes $1\frac{1}{2}'' \times \frac{1}{2}''$ closed with a pad of dry cotton wool provided with a drop of water on the pad moistened daily, the average length of life during winter was 8 days for males and 12 days for females.

Four unmated females, kept singly in glass blocks and supplied with nymphs on leaves which were changed daily, lived for 20 days. Others were liberated in tubes of $4\frac{1}{2}'' \times \frac{1}{2}''$ covering small shoots of Citrus plants kept in water in glass tubes and having nymphs of Psylla. In these they lived for 25 days.

Side by side a few of these parasites were also confined in sleeves on shoots of trees having Citrus Psylla outside in the field ; these lived for 25 days.

The longest life of a female recorded is 31 days, and that of a male 36 days (in one case only). The male emerged on 11th December 1922 and died on 16th January 1923 while the female emerged on 16th December 1922 and died on 16th January 1923.

Life-cycle of the parasite.—A series of experiments was designed to observe the power of reproduction and average duration of life-cycle of the parasite. The freshly emerged parasites were supplied with healthy nymphs on young *Citrus* (*Khata*) plants transplanted in small earthen pots. The shoots of these plants were enclosed in glass tubes.

Out of ten females kept, only one happened to lay eggs. Only in 3 cases was the life cycle obtained. The difficulty in these cases was that, without disturbing and turning the nymphs on the ventral sides, it was not possible to observe the eggs of the parasite, and, if once disturbed, the nymphs settled again with difficulty. In many cases the nymphs left the plant and thus the eggs did not hatch or the grub separated from the nymph on account of constant disturbance caused by the movement of the nymph.

The following table gives the different periods observed in each stage. The pupation was noted from the date of fixing the nymphs by means of silken threads.

Table showing the variation in length of the life-cycle of Tetrastichus radiatus *reared from eggs got in the Laboratory.*

Date of observation of eggs.	Date of hatching.	Date of fixing.	Date of emergence.	TOTAL.	REMARKS.
5-xii-1922	11-xii-1922	26-xii-1922	8-i-1923 .	34	The grub was kept in the incubator.
4-xii-1922	9-xii-1922	25-xii-1922	17-i-1923 .	43	
21-xii-1922	26-xii-1922	10-i-1923 .	...	...	

Table showing the variation in different stages as collected from the field.

Date of collection of eggs.	Date of hatching.	Date of fixing.	Date of emergence. of parasite.	REMARKS.
2-xii-1922 .	3-xii-1922 .	19-xii-1922 .	14-i-1923 .	Male.
7-xii-1922 .	8-xii-1922 .	22-xii-1922 .	16-i-1923 .	Male.
14-xii-1922 .	16-xii-1922 .	30-xii-1922 .	26-i-1923 .	Female.

Conclusions.—The facts so far ascertained have been recorded here, and this account calls forth many points for further inquiry. The work is being continued and we hope to bring to light more facts regarding the parasites.

During the observations two different hyper-parasites have so far been reared and on account of the very small number of these parasites further facts regarding their life-cycle and reproduction have not been observed so far. It is also not known whether some of these primary parasites may act as secondary ones.

The percentage of parasitization is not so high with us. We have not observed any hyperparasites. We find this insect on *Cordia cordata* and *Murraya koenigii.*

21.—THE CITRUS WHITE-FLY, *DIALEURODES CITRI*, IN INDIA AND ITS PARASITES, TOGETHER WITH THE LIFE-HISTORY OF *ALEYRODES RICINI*, n. sp.

By Rai Bahadur C. S. Misra, B.A., *First Assistant to the Imperial Entomologist.*

A perusal of the American literature shows that *Dialeurodes citri*, Ashm., is a serious menace to the well-established and flourishing *Citrus* industry of California. The pest has become so well established there that all attempts to bring it under control have not hitherto proved successful. The Citrus White-fly, *Dialeurodes citri*, Ashm., seems to be on the increase and all mechanical measures to bring it under control have not proved so successful as was expected, and attempts are being made now to control it by the introduction of parasites and predators from the East, which is supposed to be the home of *Dialeurodes citri*. We began making collections of Aleyrodidae early in 1907 and were struck with the heavy infestations of *Bela* (*Jasminum sambac*) and castor (*Ricinus communis*). Four years later we again had trouble with our castor plantations for the adequate supply of castor leaves to feed Eri worms (*Attacus ricini*). The majority of the plants in the plantations at Pusa were infested so heavily that it became a problem to arrange for the supply of clean healthy leaves to the worms. It was at this time that we were struck with the presence of small, pale yellow Chalcididae parasitic on the nymphs of Aleyrodids on castor leaves. In April 1913, Professor J. R. Watson, of the University of Florida, asked us to help him in introducing the internal parasites and predators of the Citrus White-fly which was reported to be present in sufficiently large numbers on *Citrus* spp. in North-West India. An examination of the material which had been collected since 1907 revealed the fact that although *Dialeurodes citri* was present on *Citrus* spp. at Pusa, it was more plentiful on *Bela* (*Jasminum sambac* and *J. arborescens*). The white-fly seemed to prefer *Jasminum* spp. more than *Citrus* spp. on which it was to be seen in very small numbers, so much so that its presence on the *Citrus* plants could be considered as negligible. The citrus white-fly has been found to occur at Kulu and Lahore in the Punjab, Peshawar, Sikkim, Khasi Hills, Poona Nagpur and Pusa. It has not hitherto been

reported from Ceylon. But I think this meagre record of its distribution in this country is simply due to insufficient collections being hitherto made of this group. The insects being small and inconspicuous, and at times occurring along with other insects, such as Coccidae and Aphididae, escape detection and collection, unless one is particularly interested in the group, and makes a special collection of it. The adults are small and active during the day and as such are not easily collected. It is more or less due to this that in many species the adults are not yet known and as such have not been described. Continuous collection of material at Pusa brought out the fact that along with *Dialeurodes citri*, *Dialeurodes citrifolii* (*Aleyrodes nubifera*) and two other species of Aleyrodidae were also present on *Jasminum* spp., and we wrote back to Professor J. R. Watson, Gainsville, Florida, whether he wanted the internal parasites of *D. citri* particularly or any other closely allied species from which the parasites could be reared, identified and then despatched to him under special arrangements in cold storage on board the ships proceeding to America. To this he replied : "......Practically it makes little difference whether the white-fly material is gotten from *A. citri* or a closely related species. What we are after is enemies of *A. citri* and anything you may find infesting *A. citri* or a closely related species" ....The work of rearing the parasites of *Dialeurodes citri* commenced by the beginning of June 1914 and was continued until the end of the year. Whilst this was going on, the life-history of *Aleyrodes ricini* was also being worked out and it was found that this Aleyrodid contained the true internal parasite of *Dialeurodes citri* in larger numbers than those that could be reared from *D. citri* on *Jasminum sambac*. The Chalcid parasite, *Aphelinus fuscipennis*, was reared for the first time from an *Aleyrodes*. Previous records show that members of the genus *Aphelinus* do not parasitize Aleyrodidae but we reared many specimens of *Aphelinus fuscipennis* and satisfied ourselves that the true internal parasite of *D. citri* was also the true internal parasite of *A. ricini* as the latter was very abundant on *Ricinus communis*. We therefore decided to take advantage of this and accordingly arrangements were made to despatch a few consignments of these in cold storage to Gainsville on board ships proceeding to America from Bombay.

Another internal parasite of *D. citri* was reared from *A. ricini* and this was a new species of *Prospaltella*. Mr. W. R. Woglum, when he was deputed to find out the parasites of the citrus white-fly, had found *Prospaltella lahorensis* parasitizing *D. citri* at Lahore. A reference being made to Professor J. R. Watson, he very kindly furnished us with the following description of the male and female *Prospaltella lahorensis*, How.

SUBFAMILY APHELININAE, HOWARD.

Genus *Prospaltella*, Ashmead 1904.

Prospalta, Howard 1894 (Preoccupied).

Prospaltella lahorensis, *Female*.—Length, 0·54 mm.; expanse, 1·42 mm.; greatest width of forewing, 0·25 mm. Antennae long, not clavate; scape long, slender; pedicel nearly as broad as long; first funicle joint somewhat longer than second; second and third subequal; club equal in length to second and third funicle joints together; terminal segment of club slightly longer than middle segment, basal segment again slightly shorter. Forewings broad, with moderately long bordering cilia; disc uniformly covered with minute cilia; stigmal vein rounded below, its anterior margin for a time parallel with costa; marginal vein faintly indicated, its base joining stigmal in an acute angle. (In this respect this species differs from all other known species of its genus.) General colour light yellow; all legs pallid; eyes dark; ocelli coral-red; antennal club dusky; wings hyaline, wing veins dusky.

Male.—Of practically the same size and structure as the female, but differing in colour. The colouration closely resembles that of *Aspidiotiphagus citrinus*, to which it bears a superficial resemblance; pronotum, brownish; mesonotum, orange-yellow; metanotum and epimerum, brownish; abdomen dark brown except at base and tip where it is lighter; hind femora dusky at tips; wing veins distinctly fuscous, considerably darker than in female.

The species of Aleyrodidae occurring on *Ricinus communis* has been known hitherto as *Aleyrodes ricini* and no full description of the species has appeared up till now. I now give here a full description of it below. The species belongs to the genus *Aleyrodes* and as it occurs in large numbers on *Ricinus communis*, I propose to call it *ricini*. This Aleyrodid is very common on castor at Pusa, and has been received from Nagpur and Coimbatore, but I think it is widely distributed, information regarding its distribution being incomplete owing to lack of collections being made of this group; if, however, it be looked for on castor, it will be found to have a fairly wide distribution in this country. The adults swarm in numbers on the lower surface of leaves, and all the stages are passed on castor leaves on the lower surface. In some years in the past, it was so plentiful that badly infested castor leaves when fed to eri worms had a prejudicial effect on their development. In the year 1908, when it was extremely bad on castor leaves, *Aspidiotus orientalis* happened to be present on a serious scale on the stems, and the result was that the whole of the plantation had to be cleared off so as to prevent

infestation of the newly-sown plants not very far off from the infested plots. Ever since, the castor white-fly has occurred more or less on the castor plots for the past fourteen years. The adult fly lays creamy white eggs on the lower surface of leaves. The maximum number of eggs laid by a female has been found to be eighty-three, the minimum as low as three to five. The eggs laid by females have varied from 52, 75, 63, 25 to 83. All the eggs are not laid in a mass; the female rarely lays all the eggs in one sitting. If she is disturbed in the least, she readily takes to the wing and starts laying eggs either on another part of the same leaf or on another leaf altogether.

The egg.—Eggs are to be found in small clusters lying all about the lower surface of a leaf. The eggs are creamy white in colour and as such are not seen easily with the naked eye against the thin bloom present on the leaves of some varieties of castor. The eggs lie losely on the lower surface of leaves. When in groups of three to six or any number up to seventy-five each egg touches the other at the side. The eggs are attached to the surface of the leaf by a short peduncle. Each egg is 0·16 mm. long and 0·50 to 0·60 mm. broad, elongate cylindrical somewhat broad at the end where the peduncle is attached. There is no bloom on the egg masses, and the chorion is not tessellated. As the egg matures the proximal end where the peduncle is attached becomes suffused with pale yellow with two small, ovoid yellowish spots. When about to hatch, a slit opens on the distal end and a tiny pale yellow larva comes out. It immediately begins to move about and has been observed to fix itself in from 7 to 22 minutes. If the leaves are free of *Tetranychus bioculatus* and the Jassid leaf-hopper (*Empoasca flavescens*), the nymph has no difficulty in finding a fairly succulent spot to fix itself on. It then appears as a tiny, pale yellow spot and is hardly discernible against the pale-greenish background of the infested leaves. The empty egg-shells remain attached to the lower surface of leaves. Repeated attempts have been made but no egg-parasite has yet been found.

Larva. First Instar.—The larva is 0·35 mm. long and 0·17 mm. broad, pale in colour, a faint cretaceous white fringe all round the margin; eyes elliptical, deep chocolate. Three to four faint transverse carinations on the lower thoracic region. Five to six transverse, faint lines on the abdomen dorsally, such lines becoming indistinct towards the margin in the region of the marginal pores. Vasiform orifice distinct, broad at base, broadly pointed at the apex, operculum not entirely covering the mouth of the vasiform orifice, distinctly broad at base. Lingula pale yellow, projecting beyond the operculum, somewhat apically narrowed. Two short, bent, stout hairs at the posterior margin cephalad of the vasiform orifice. The chitin being thin and transparent, two

ovoid yellowish pigmentary patches on the mid-abdominal region dorsally; in some nymphs, the two patches run into each other, forming a distinct, deep yellow transverse band on mid-abdomen dorsally.

Second Instar.—The second stage larva is 0·42 mm. long by 0·25 mm. broad; elongate, elliptical, pale yellow in colour. Eyes deep maroon; the portion near the thoracic region latero-dorsally extending as far down the two deep yellow pigmentary spots on mid-abdomen both sides yellowish in colour; cretaceous fringe at edge of nymph dull white; transverse lines on the abdomen dorsally distinct; two broadly ovoid pigmentary spots on the abdomen dorsally deep yellow in colour, vasiform orifice broad at base, broadly pointed cephalad; operculum not entirely covering the orifice; lingula pale yellow, distinct, broadly pointed posteriorly lying between the posterior edge of the vasiform orifice and the operculum, distinctly visible under a handlens. Two short, inwardly bent, stout hairs, at posterior edge cephalad of vasiform orifice. These are faintly discernible in the whitish fringe surrounding the peripheral edge of the larva, but in such specimens where the fringe is rubbed off, the two hairs may be distinctly seen with a handlens magnifying 10 diameters.

Third Instar.—Length 1·14 mm. Breadth 0·86 mm. Length of marginal waxy fringe 0·24 mm.; shape elongate-oval; colour bright yellow tinged with fuscous; ~~eyes~~ minute, represented by two jet black spots (seen under high magnification); margin, anterior cephalic transverse band, two large ovoid spots on dorso-mid-abdominal area, vasiform orifice, triangular patch caudad of vasiform orifice bright pale yellow; anterior cephalic, posterior thoracic, and anterior abdominal area, sub-marginal area, area between two oblong-ovoid pigmentary spots and the vasiform orifice dark yellow. Median area raised, distinct from the sub-marginal areas which are somewhat depressed. Three transverse lines on the thoracic regions distinct, the posterior one separating the thorax from the abdomen, five short wavy lines on the median dorso-abdominal area distinct; these do not pass over the sub-marginal areas; vasiform orifice sub-cordate, anterior margin straight, the apex pointing caudad, somewhat raised, operculum reaching to nearly half the length of the vasiform orifice, lingula pointing slightly out between the operculum and apex of orifice; lateral edges of orifice, as well as operculum, dark brown.

Fourth Instar.—In this instar there are not many changes except that the dorso-median area becomes dark yellow and distinct. The anterior yellow band and the posterior two oblong ovoid pigmentary spots disappear. The head, thorax and abdomen become prominent with the vasiform orifice.

Puparium.—Length inclusive of the waxy fringe 1·17 mm.; breadth over mid-dorsum inclusive of the fringe 0·81 mm.; length of waxy threads constituting the fringe 0·21 mm., the wax-threads bend somewhat inwardly anteriorly; shape elongate oval; colour bright pale yellow with a dull white waxy fringe all round; sub-marginal area dark pale yellow, the derm when seen under high magnification consists of small pores which secrete minute globules of cretaceous white wax, on account of this the area appears suffused with a thin whitish meal, cephalad these globules coalesce to form thin whitish streaks on the anterior of the thorax and the vertex. The anterior coalescence produces a longitudinal faint streak extending from middle of vertex to the base, the posterior coalescence produces a faint white streak which runs transversely separating the thorax from the head. A distinct transverse wavy suture on mid-dorsum separating the thorax from the abdominal region. A longitudinal suture extending from the base of the vertex meets the transverse suture in the middle in the median area. The abdominal median area has laterad a pair of thin cretaceous white waxy-lines approximately touching each other caudad of the vasiform orifice, which is concolorous with the dorso-submarginal area. It is prominent, subcordate with the apex pointing caudad, with a shallow groove running caudad in continuation of the apex of the vasiform orifice to the posterior margin. Operculum prominent, bright pale yellow, extending to about or a little beyond the centre of the vasiform orifice. Lingula prominent, concolorous with the operculum, extends beyond it to about half its entire length but hardly reaching the inner edge of the apex of the vasiform orifice.

The upper edge of the puparium stands out prominently against the leaf surface, and if the marginal waxy fringe be removed, the puparium is seen to stand boldly against the greenish background of the leaf.

The parasitized puparia have a circular hole on the anterior part of the puparium mostly lying midway between the thoracic and the abdominal regions. The majority of the parasitized puparia turn black, and even when the parasite has emerged, the cuticle of the puparium remains black, especially the dorso-abdominal marginal area and the area enclosing the vasiform orifice. In the majority of cases examined, the hole of exit of the parasite has been found almost invariably situated in the thoracico-abdominal area, rarely in the posterior or in the vasiform orifical area.

The adults become torpid with cold, but become active during the day. In the early morning hours they may be seen in swarms on the apical tender leaves. From occasional counts made of the adults it was found that the females outnumber the males.

Life-cycle.—A complete life-cycle from July to September lasts from 19 to 21 days :

Month.	Eggs laid.	Eggs hatched	Adults emerged.	Length of Life-cycle (days).
July 1914 . . .	8th .	...	28th . .	20
Do.	31st .	9th August .	21st August .	21
August 1914 . .	31st July .	...	19th August .	19
September 1914 . .	6th .	10th . .	25th . .	21
January 1908 . .	21st .	9th February	16th March .	56
March 1908 . .	24th .	1st April .	16th April .	23

Distribution throughout the year.—Eggs, nymphs and adults are found in numbers on the leaves from February to end of November. It is only during December and January that the number of adults becomes less. With the beginning of February, egg-laying starts in profusion and the tender apical leaves may be seen swarming with adults.

Parasitization.—The number of parasitized larvae and puparia is the largest from June to August. The parasitized larvae and puparia turn dark-grey to black and could be easily detected with a handlens. The parasites are present on larvae of second to fourth instars as well as the puparia, and if one of these is opened out, a tiny greenish-white Chalcid grub with russet brown mandibles will be seen within. When the adult parasite emerges, it makes a circular hole on the dorsum and comes out. Two parasites have hitherto been found parasitizing the larvae and puparia, *Prospaltella* sp. and *Aphelinus fuscipennis*.

Predators. Clanis soror (*Cryptognatha flavescens*) preys upon the larvae, puparia and egg-laying females. Besides these, *Chrysopa* larvae attack and devour the larvae, as well as the egg-laying females. The grubs may be seen slowly moving about and resting to feed upon the larvae and puparia. The beetle, when full-fed, pupates on the leaf, and adults may be seen on badly infested leaves.

When the larvae and puparia are present in numbers on the leaves, so much honey-dew is excreted that it falls on the leaves below and breeds the fungus *Cladosporium* sp. (near *herbarium*).

22.—A NOTE ON *PARATELPHUSA HYDRODROMUS*, HERBST, THE FRESH-WATER CRAB OF SOUTH INDIA.

By Rao Sahib Y. RAMACHANDRA RAO, M.A., F.E.S., Acting *Government Entomologist, Madras, and* P. SUSAINATHAN, F.E.S., *Entomological Assistant, Madras.*

Habits and nature of damage.—In most crabs, especially the marine ones, eggs laid by the female hatch into strange-looking forms known as Zoea larvae very much unlike the adult ones and it is only after a series of moults that they change into individuals resembling the adults, but in the case of *Paratelphusa hydrodromus*, Herbst, eggs laid by the full-grown female are attached in great masses to the leaf-like abdominal appendages and are carried about by her under the secure protection of the flexed abdomen. Females with eggs are first noticed about May and by the time the canal water reaches the paddy fields in June the young crabs are ready to hatch out. Females "in berry" and just-hatched crabs are quite abundant in July and August. From September onwards neither gravid females nor very young crabs are to be found.

The breeding season thus seems to fall between June and August corresponding to the incoming of canal water in that delta. Newly hatched crabs are quite tiny and are of a milk-white colour. As they feed they moult and gradually grow in size. Growth is not stopped at maturity, as in insects, but continues to some extent even after maturity so that there is a great disparity in size even among adults.

A great feature of the crab is its ability to burrow. The great pincer-legs serve both as a spade and a shovel. The earth dug is carried held between the chelae and the chest and neatly shoved out from the top of the burrow. The hole, in addition to forming a safe retreat from pursuit by enemies, seems to be dug out mainly for getting a supply of water for the gills. In paddy fields, where water has been drained off, crabs burrow down till they reach the water level. During the long summer season the crabs burrow very deep, as deep as three yards according to the *raiyats*, at which depth apparently they find sufficient water or at any rate moist soil. More than one crab, male or female, is never found in a single burrow.

It was not possible to make any definite observations on the food of these crabs during the summer months, but it is probable that they issue from their burrows and hunt after prey at night. It was curious

to note that the crabs were always ready to go up to the mouth of the holes when a gentle chirping or a slight continuous sound resembling the note of a cricket was made at the mouth of the hole. Bits of straw, paper or packets of sulphur when thrust two or three inches into the entrance of the holes were all found carefully removed to the bottom of the holes and there nibbled at by the crabs. This habit of theirs suggested the use of poison baits, which were readily taken by the crabs. These crabs are usually carnivorous, feeding on small fish, tadpoles, grasshoppers and worms and an examination of their gizzards has revealed the presence of scales of fishes, portions of insects, and also of bits of plant tissues. Though a herbivorous habit is rather a strange one for a crab, yet actual observations have been made which prove that this crab is really destructive to paddy.

Soon after the seedlings are transplanted the activities of the crabs become manifest. In bad cases nearly 50 per cent. of the seedlings may be destroyed. Usually numerous blanks are created which, when replanted, may again be attacked. After the plant becomes established it is not attacked by the crab. The damage is done mostly when there is a large quantity of standing water in the fields and considerably diminishes when the water is drained off.

On a comparison of the damage done by crabs to the paddy crop on the Government Farm with the crop on the adjoining *raiyats'* lands it was found that the damage was more severe on the Government Farm owing to the method of single planting adopted there, whereas the *raiyats'* fields suffered very much less by reason of their practice of planting seedlings in clumps of six to twenty.

The crabs that cut up the seedlings are mostly four to eight weeks old. They live in holes in the *bands* and beds. The young transplants are nipped at ground-level and the bits carried into holes and convenient cracks and there chewed. These crabs are crepuscular in their habits, most probably continuing their depredations far into the night. But there have also been instances where the crabs cut in broad daylight. Mr. F. R. Parnell, Government Economic Botanist, Coimbatore, observes : "I have several times actually seen crabs stripping the bottom ends of cut-off plants and once watched one pulling down a head, which was hanging low, and eating the young grain on it."

Natural checks.—Among the predatory birds both the Pariah kite (*Milvus govinda*) and the Brahminy kite (*Haliastur indus*) are confirmed enemies of the crab during the day time. It is a common sight to see them swooping down and carrying off an unfortunate crab to a field *band* or to the bough of a tree where the legs and shell are torn off piecemeal and the body devoured. The great quantity of broken shells

and legs, whitened by exposure to sun and rain, that one meets with on any field *band*, is sufficient testimony to the destruction wrought among crabs by these birds of prey. Storks and cranes, but especially the Pond Heron (*Ardeola grayi*), are inveterate enemies of crabs, especially of immature ones. At night jackals hunt for crabs and account for a good number, as is evidenced by the abundance of the exo-skeletons of crabs in their fæces.

The bronchial chambers of these crabs are found to be infested by a species of leech. Leeches are generally suckers of blood and in this case they are very probably true parasites on the crab, attacking the membrane of the bronchial chamber and the gills and sucking the body juices. Generally three or four may be found in each crab, but in one case fourteen large leeches, besides two or three tiny young ones, were noted in a single crab. It is, however, doubtful if the leech, even if present in large numbers, will form any efficient check on the crab.

At the paddy breeding station at Coimbatore, numerous dead crabs were in 1915 noted in the field. The cause of their death could not be ascertained and investigations into the matter as to whether it was due to any infectious bacterial disease would probably have yielded interesting results.

Remedial measures. (*i*) *Hand-collecting.*—The crab is edible and forms a constant item of a day's meal among the lower labouring classes in the Tanjore deltaic area. Be the weather wet or dry, the womenfolk always collect a few crabs almost every day, for food. When the fields are flooded it is not difficult to catch them, but during the dry season it is not quite so easy. The usual procedure adopted is as follows. The men get hold of a slender bamboo pole, tie at one end a bunch of empty snail-shells and at the other a rather stiff tough cord run into a noose. The end with the bunch of shells is first inserted into the mouth of the hole and jingled, whereupon the crab, cheated, according to the people's view, into the notion that the canal water is rushing in, comes slowly out. The other end with the noose is now thrust in and immediately the crab snaps at it with its pincers. The noose is now twisted round the legs and the crab is pulled out.

In cases where particular fields have to be specially protected the attention of the people may be attracted by setting a price on every mature crab so that as many of them as possible may be destroyed. When the major number of the female crabs are thus captured the number of the young crabs will assuredly have decreased and the greater part of the damage be averted.

(*ii*) *Crab-pots.*—Narrow-mouthed earthen pots filled with kitchen refuse could be set in the fields, along water channels, etc.; but these

pots have not been found successful in trapping a fair number of crabs, although this method appears to have been used with some success elsewhere.

(*iii*) *Spraying.*—Crude-oil emulsion, in the strength of 1 lb. of emulsion to 10 gallons of water, and fish oil soap, at a strength of 1 lb. of soap to 16 gallons of water, were thickly sprayed in two different equal-sized plots and again over a belt one foot wide along the margins of a large seedling plot. In the first case the object was to see whether the crabs were repelled from the sprayed plots and in the second to test the efficacy of a marginal ring of spray the smell of which might prevent the crabs in the *bands* from crossing into the main field. These sprayings were disappointing, as the experiments had not the desired repellent effect upon these crabs.

(*iv*) *Wire-netting.*—A small plot of lusty seedlings was hedged in by galvanised wire-netting of ½″ mesh, care having been taken to extract all the crabs from holes or crannies. The plot thus enclosed was kept under observation. As compared with the neighbouring unprotected plots, wire-netting conferred a real protection inasmuch as the crabs did not get into the enclosed plot nor did they appear to be able to climb over. Keeping off the crabs by netting of this sort would be prohibitive in large areas but might be advocated on a small scale as far as nurseries are concerned, for it is here that wholesale damage occurs. This method is particularly recommended in experimental plots of breeding stations where every seedling counts. A four-mesh wire gauze is probably required in the earlier stages rather than a two-mesh one.

(*v*) *Fumigating.*—Treatment of the burrows was tried, using carbon-bisulphide, a dilute solution of potassium cyanide and sulphur arsenic fumes, pumped in by the ant exterminator, and in all cases with success; but, owing to its cost and the dangerous nature of the chemicals, these methods cannot be generally recommended.

(*vi*) *Poison-baiting* is only practicable during the hot summer months when the crabs are hard up for food and confined to the burrows. A bait composed of :—

Paris green	1 oz.
Rice bran	1 lb
Molasses	3 ozs

was tried in the beginning of March 1917 at the late Government Agricultural Station at Manganallur (Tanjore District). All the crab holes in the southern half of the farm wetlands were treated. The method was to drop into the crab holes a pellet of the poisoned bran-mash of the size of a pigeon's egg. Holes along water channels and *bands* enclosed

by or adjoining this area were also treated. A total area of 42·4 acres was tackled and 21,002 crab holes were found in the area ; 454 lbs. of bran, costing Re. 1-8-0, 1,362 ozs., or roughly 85 lbs. of molasses, costing Rs. 2-8-9, and 28 lbs. of paris green, costing Rs. 24-0-0, were consumed, bringing the total cost to Rs. 28-0-9, or roughly 0-10-6 per acre. The average number of crab holes per acre was between 500 and 600. Generally speaking, 85 to 95 per cent. of treated holes showed dead crabs when dug out 6 to 8 days after treatment : evidently the crabs *had* fed on the poisoned stuff.

The coastal rice areas in Malaya suffer considerable damage from burrowing Crustacea. This is not however mainly due to the cutting of the rice stems but to the loss of irrigation water and in some cases to letting in salt water in the fields. The damage is mainly caused, not by crabs, but by a lobster-like burrowing Crustacean, *Thalassina anomala*. This animal excavates considerable tunnels which descend to low water-level and may have extensive underground ramifications sometimes passing under the bunds. As an average-sized *Thalassina* makes a tunnel along which one may pass one's closed fist, it is easy to appreciate that irrigation water is rapidly lost through a few such workings. *Thalassina anomala* is a mud-swallower and passes through its body very considerable quantities, the residue from which is ejected in a semi-fluid condition around the mouth of a vertical shaft. Successive evacuations result in cone-shaped mounds of mud of considerable size with a round shaft down the centre. This shaft is utilized by crabs and, as *Thalassina* is rarely seen, the construction of the mounds is usually ascribed wrongly to the crabs. This mistake has been made in the rice areas along the coast of Malaya, where *Thalassina* is extremely common, until we had an occasion to investigate the matter. I mention this as it is probable that *Thalassina* spp. extend up to the Bay of Bengal and similar damage may be taking place in India. Excavation along the tunnels from any such cones of fœcal mud will demonstrate the true author.

I have seen such mounds in the Kamrup district in Assam and the question may be worthwhile investigating as the occasion arises.

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PLATE 8

1 2

Crabs damaging paddy in Burma ; 1, *Potamon dayanum* **: 2,** *Varuna litterata.*

23.—CRABS DAMAGING PADDY IN BURMA.

By C. C. GHOSH, B.A., F.E.S., *Assistant Entomologist, Burma.*

(Plate 8.)

Broadly speaking, two kinds of crabs occur in the paddy fields in Burma, *viz.*, quasi-sea crabs and land crabs.

So far as known, the quasi-sea crabs (*Varuna litterata*, F.), commonly called *Phaung-si-ganan* (literally "raft-riding crab" on account of their habit of mounting on floating logs, etc., while moving with the tidal water), occur in all the sea-coast districts in Lower Burma, especially in Amherst, Thaton, Hanthawaddy and Myaungmya. The adult crabs are small flat creatures, the body being about the size of the thumb-nail (see Plate 8, fig. 2). They go down to the sea with the tidal water in the early part of July and never return. They breed in the sea. The young crabs come up to the fields in the latter part of August or September and live in the fields until July next year when in their turn they move down to the sea. The dates of these annual migrations vary a little from place to place and are known to the local cultivators. Germinated paddy seeds are broad-casted after the departure of the adult crabs and the plants grow sufficiently by the time the young crabs come up. Therefore hardly any damage takes place. The adult crabs nip the young shoots if the seeds are sown before they depart. The only complaint at present against these crabs is that, owing to their presence, sowing cannot be undertaken early. The present practice, however, seems to be the best. These crabs occur in such numbers that while they migrate they cover the entire surface of land and water. Attempts at fighting them over miles and miles of paddy fields will be expensive and probably fruitless. Some accounts given by Mr. Shroff of other crabs occurring in these fields, *viz.*, *Metaplax dentipes*, Heller, *Sesarma edwardsi*, de Man, and *Gelasimus acutus*, Stimp. will be found at pp. 689-694 of the *Proceedings of the Third Entomological Meeting*. The cultivators complain only of *Varuna litterata*.

Land crabs occur on high lands throughout Burma, both in the Plains and Hills, the commonest species being *Potamon dayanum* (Plate 8, fig. 1). They are especially common in the fields which are cultivated under irrigation. Young ones are brought forth about June to August and

are carried very easily by the irrigation water, which therefore helps them to spread. They continue to live in the fields and take about three or four years to become full-grown. They come up to the surface in the Rains, going underground and resting there during the other seasons. The adult crabs are capable of walking over the mounds and embankments in the fields and no doubt spread in this manner from field to field. But it is the irrigation water which helps the young ones to spread in numbers and to long distances. The beds of irrigation channels offer ideal places for these crabs to live and breed and on this account harbour numbers of them. Breeding also takes place in the fields already infested. As no attempts are made to check these crabs, beyond the destruction that is effected by crows, herons, etc., and by the people occasionally catching and eating them, their number has increased enormously in some places. The number disposed of by the natural enemies seems to be small, especially as their habits are mainly nocturnal, the day-time being passed by the majority securely in holes, while the rapidity of increase is accounted for by the fact that the females produce from 490 to 781, or on the average more than 650, eggs each.

These crabs cause trouble in two ways, *viz.*, by boring holes in the *Kazins* (mounds between the fields), allowing the water to run out, and by cutting across the plants, especially newly transplanted seedlings. The first form of trouble is hardly of much importance. But it becomes necessary to fill up the gaps caused by the destruction of the plants, very often repeatedly. This means additional expense, use and unnecessary reserve of more seedlings and lateness of operation. This was exactly the condition last year (1922) in a block of land in the Mandalay Farm about 16 acres in area and planted with a variety of early-maturing Japanese paddy (*Hoito*). The species of the crab concerned was *Potamon dayanum*. The cultivation was, as usual, with canal water. The area under paddy was divided into 66 plots, each about one-fifth acre, with two larger plots occupying more than an acre on one side. Out of the above 66 plots fifteen, situated about the middle, were further sub-divided into smaller plots about one-twentieth acre each. On the south and west side the area had clear high land. On the north side, immediately adjoining it, there was a belt of uncultivated low land under water with grasses growing on it. On the east side a dry crop of *Andropogon* was being grown. In between the plots there were small distributaries for water and five uncultivated strips about four to five yards in width and running across the entire area from north to south, the strips being overgrown with grasses and remaining under water.

In the beginning, cutting of the transplanted seedlings could be prevented by allowing the water to run into and remain in the plots during

the day-time and draining it out at night. It was observed that more damage was done in the plots which remained under water at night. Regulation of the water in this manner was a difficult matter (not always practicable) and became impossible when the Rains commenced. The following experiment was therefore undertaken to trap the crabs. The traps used were ordinary wide-mouthed (majority of them) and big-bellied earthen pots, about ten to twelve inches high. They were set here and there in the places where damage could be observed in the cultivated plots as well as in the uncultivated strips. All were sunk in the ground so as to leave their mouth clear of water and earth was placed all round so as to enable the crabs to crawl into them easily. Also no water was placed in them. But soon afterwards with the commencement of the rains they frequently got under water and many of them remained so for long periods. With the progress of the work it soon become apparent that the presence of water in them was an advantage. The largest catches were obtained on the days when all the traps remained under water and the largest catch, *viz.*, 43 in a single trap in a single night, was in a pot like this. It may be stated here that pond crabs, used by some as food in West Bengal, are trapped in earthen pots baited with boiled rice and sunk under water.

The bait used in the traps was (1) *Ngapi*, the fish paste forming the "highly delectable national food" in Burma. It is prepared in the following manner. If the fish be big, first of all its scales are removed and then it is cut into pieces. The small kinds are used entire, even removal of their scales being considered unnecessary. The fish is washed well and mixed with about one-fourth to half its weight of salt and kept in a closed earthen pot. In about ten to twelve days the whole thing rots and gets ready. It is then pounded with a pestle and mortar and made into a paste. Sometimes it is adulterated with rice flour, or even husk dust (*Phoenu*). *Ngapi* also sells in an unpounded condition but costs more than the paste. The price of *Ngapi*-paste is 14 annas to one rupee and eight annas per *vis* (3½ lbs). A kind of *Ngapi* is also prepared with crabs.

(2) *Ngapi*, fried over fire.

(3) Oil-cake, fried over fire.

(4) Fine rice-husk-dust called *Phoenu*, fried over fire. It is obtained in cleaning the rice grains and contains broken particles of the grain.

(5) Mixture of fried oil-cake and *Phoenu*.

Ngapi was used for the first few days and proved too costly. The mixture of fried oil-cake and *Phoenu* proved to be the best bait. After frying, the oil-cake was pounded and mixed with fried *Phoenu* and then

made with water into balls, each about one-third the size of a fowl's egg. The ball was placed in the trap and a little (just a pinch) of the dry stuff spread near the mouth of the trap or smeared on the mouth. Oil-cake alone was used on 25th, 26th and 27th August, when the catch decreased, but jumped up on 28th on the addition of *Phoenu*. A similar effect was observed when *Phoenu* alone was used on 31st August to 4th September (see the figures of these dates in the table below). The bait was placed in the evening and the collection of crabs from the traps made every morning.

The work was started on the 3rd August and stopped on the 29th October. As the number of traps was gradually increased and there were gaps during October the period is divided as below :—

Period.	No. of traps worked.	Total No. of crabs trapped.	Bait used.
3rd August	6	13	*Ngapi.*
4th-5th August . . .	14	98	*Ngapi* fried.
6th-10th August . . .	28	466	Ditto.
12th-13th August . . .	32	217	*Ngapi* and oil-cake.
14th August . . .	39	132	Do. and *Phoenu.*
15th August to 30th September. Total 47 days.	71	16,394	Oil-cake and *Phoenu.*
1st to 3rd, 5th-7th, 10th-19th and 25th-29th October. Total 19 days.	71	3,200	Ditto.

The total catch was 20,520. Out of these 10,607 were males and 9,913 females. As regards size those more than half-grown were classed as large and those about half-grown and less were considered small, excluding however the very small newly-hatched ones. According to this grouping, out of the above total catch 17,597 were large and 2,923 small. The females carry the young ones for some days before liberating them. Frequently 500 or 600 newly liberated young ones would be found in the traps and were considered as the offspring of one female. Including such females, the number of egg-bearing and young-bearing females trapped was about 300. Taking about 650 eggs per female the number disposed of was about 195,000. No gravid female was met with after August. Breeding on a large scale apparently takes place much earlier than August. But from general observation it was clear that many crabs did not issue out of their underground resting places unless it rained heavily. The first heavy showers fell between 23rd and 26th August (more than $2\frac{3}{4}$ inches). They called forth many crabs in places

where their presence could not be detected before and soon many holes were opened up. Flooding the fields with irrigation water has the same effect whether it rains or not.

The statement below gives an analysis of the number of pots, trapping varying numbers of crabs on each day from the 15th August to 30th September. During this period the traps were carefully worked and the average per pot per night worked out to about 4·9.

Date 1922	Total trapped crabs in 71 pots.	Pots with 5 crabs and above.	Pots with 10 crabs and above.	Pots with 15 crabs and above.	Pots with 20 crabs and above.	Pots with 25 crabs and above.	Pots with 30 crabs and above.	Pots with 40 crabs and above.
15th August	145	9	1	..	..	..	..	..
16th August	86	3	..	..	..	..	..	..
17th August	249	14	4	..	..	..	..	..
18th August	282	16	6	2	..	1	..	..
19th August	357	26	7	3	..	..	..	..
20th August	417	20	16	2	1	..	..	..
21st August	402	22	4	3	1	1	..	..
22nd August	288	20	4	1	..	..	..	..
23rd August	748	15	17	8	6	..	1	2
24th August	467	16	7	3	3	1	2	..
25th August	500	24	13	2	5	..	..	..
26th August	154	9	..	..	..	..	..	..
27th August	100	1	..	..	..	..	..	..
28th August	436	19	9	5	2	..	..	..
29th August	339	30	1	3	..	..	..	..
30th August	306	15	3	2	..	..	..	..
31st August	267	18	5	..	1	..	..	..
1st September	244	20	3	..	..	..	..	..
2nd September	197	13	3	..	..	..	..	..
3rd September	86	7	..	..	..	..	..	..
4th September	135	7	..	..	..	..	..	..
5th September	420	17	11	4	2	..	..	..
6th September	438	23	8	6	2	..	1	..
7th September	319	23	4	1	1	..	..	..
8th September	465	24	11	5	1	..	..	..
9th September	439	25	16	2	..	..	..	..
10th September	446	28	7	5	1	..	..	..
11th September	388	26	9	3	..	..	..	..
12th September	400	30	6	3	1	..	..	..
13th September	370	29	6	2	..	..	..	..
14th September	336	31	4	1	..	..	..	..
15th September	481	41	6	1	2	1	..	..
16th September	471	29	11	4	3	..	..	..
17th September	732	39	15	10	4	1	1	..
18th September	481	42	11	2	..	..	..	..
19th September	299	31	2	1	..	..	..	..
20th September	266	19	8	..	..	..	..	..
21st September	103	2	..	..	..	..	..	..
22nd September	277	31	1	..	..	..	..	..
23rd September	208	19	..	..	..	..	..	..
24th September	229	20	1	..	..	..	..	..
25th September	243	21	..	..	..	..	..	..
26th September	133	9	..	..	..	..	..	..
27th September	263	19	5	1	..	..	..	..
28th September	320	23	5	..	..	..	..	4
29th September	299	26	5	1	..	..	..	..
30th September	356	27	7	1	..	..	..	..

In this plot the damage by the crabs appreciably diminished by the third week of August. But the work was continued to test the efficacy of the traps as long as the conditions for trapping seemed suitable and also because the number of the crabs present in the area as demonstrated by the catches proved to be very much more than was expected

and it was intended to get an approximate idea. When the crop began to mature in October and water was cut short, conditions began to prevail which would induce the crabs to go down. The catches towards the end of October came down and averaged about ·25 to ·75 per trap. This appeared to be due more to the reason just stated. About 1,250 crabs were removed from each acre and it appeared that about as many more were still left. If they depended on paddy plants for food the growing of the crop would have been impossible.

It was observed that more damage was done where there were too many *Kazins* as in the small plots and also near the uncultivated belt on the north side. These afforded shelter to more crabs than the cultivated fields.

In the same traps 193 small-sized rats were caught between 18th and 31st August and 69 more in October. They came when the water in the fields was very low. It was curious how they would swim in the water in the traps with their snout protruding out of the surface. Frequently they were cut up and eaten by the crabs, mutilated parts of their body or limbs being left. The maximum number trapped in a single night was 30 and the maximum number in a single trap on a single night was six.

When the above experiment was in progress there was damage in isolated patches in other parts of the farm. The important plots in the midst of a large area were about three acres in which single seedlings were planted in rows for single plant selection. The crabs caused some damage before ten traps were set down on the 16th August and worked till 2nd October, catching in all 1,274 crabs.

In a small plot in the midst of another large area two traps caught 276 crabs between 26th August and 2nd October.

The effect of the traps was quickly appreciable in a corner of a large field planted with *Taung-teik-pan* paddy. Six pots trapped 123 crabs between 10th and 15th August and the cutting of seedlings was stopped.

It will appear that the traps are fairly successful and within the means of all. They are best sunk wholly under water and their position indicated by a stick pitched near them. In badly infested fields about five per acre would be necessary and they should be distributed with a little judgment and more towards embankments.

Hardly any of the twenty-two thousand and odd crabs caught in the course of this work was wasted. All were utilized as food, not only by Burmans but also by people of other communities, and were on this account in great demand. In the local markets the larger ones of these crabs sell for 10 to 15 per pice. About 175 of the larger ones fill a kerosine tin. This will give an idea of the quantity trapped.

24.—A NOTE ON RAT PESTS IN BURMA.

By C. C. Ghosh, B.A., F.E.S., *Assistant Entomologist, Burma.*

(Plate 9.)

In some years rats occur in very large numbers, so as to become a plague, especially in the Hills all over Burma. Rat plagues in the Plains are less common and, as far as can be made out at present, apparently occur when the rats migrate to neighbouring tracts from the Hills. This note is intended mainly to show the conditions under which these plagues occur.

A rat plague occurred in the Leiktho Hills in Toungoo District in 1921. The writer visited this place in November. The conditions, typical of all Hill Regions, were the following. Paddy was grown in small isolated patches, often a few acres in area, or in narrow valleys extending over some distance. These fields were surrounded by hills on all sides, the hills being full of jungle which it was difficult for a man to penetrate. The area under paddy was very small compared with the hills ; a rough estimate would be less than one acre of paddy in a thousand acres of the hills. The paddy fields were fenced all round for protection against cattle and other large animals. The mounds and embankments in the midst of the fields were overgrown thickly with tall grasses. The whole place was full of rats, the majority of which were living in the hills in shallow pits in the earth and also on bamboo clumps and tree trunks. They were carrying on their foraging expeditions into the paddy fields at night and their numerous runs were easily discernible. Many had taken up temporary quarters in shallow holes in the field embankments. These holes could be easily opened up with two or three strokes of the spade or even a pointed bamboo rake. They had ramifications with several openings and were inhabited by more than one family of rats, each family consisting of a mother and seven to nine young ones. Breeding was going on at this time. Gravid females were common, of which several were opened and found to contain seven to nine young ones in their womb. There were mothers rearing up newly-born babies with their eyes and ears still closed and also mothers in the company of young ones in different stages of growth, some being about a month or more old. In all the holes, opened among the paddy fields, as well as in the jungle, there were indications of families being reared in the form of circular nest-like straw or grass beds for the litter.

Young rats were predominating in number. In a random catch over a large area about 80 per cent. were young rats. In the harvested fields there were hardly any rats present although many had lived there, as was evident from the deserted holes.

The damage was done when the paddy came into ear. The ears were cut by the young rats. It took some time to be convinced that this form of damage was due to rats. The plants were also cut near the base by the old rats. The cut ears were carried away. Husks were present in the holes and in their neighbourhood where the grains had been eaten. The damage mainly occurred in the parts of the fields adjoining the hills. The estimate of damage by the local authorities as well as by the people was about one-third of the crop. Apparently three species of rats were present. But the damage seemed to be done by only one species which predominated in number. Specimens have been sent to the Bombay Natural History Society but identifications have not yet been received.

As in all other hill places in Burma, the occurrence of the rats in such large numbers was associated with the flowering of bamboos which, according to the local people, took place after intervals of 50 years in the case of a thin bamboo called *wa-thabo* and 100 years in the case of a thick bamboo called *Ka-thoung-wa*. The last rat plague was remembered to have taken place here in 1872, when both *wa-thabo* and *Ka-thoung-wa* had flowered, and ran out its course in three years, being at its worst in the second year. It was apprehended that the present plague, due to the flowering of *wa-thabo*, would also last three years. Whatever the cause, the hills were full of rats and apparently there was plenty of food for them. The rats took a toll of the paddy grains, probably a more attractive food and grown ready for them in large quantities.

Every owner of paddy lands was said to be killing 20 to 25 rats every day by using about 100 to 200 inexpensive spring traps made with bamboo strips and set in the rat runs at night. The Township Officer reported that a million* ...... tails of rats, killed in three days in the whole township, were produced before him sometime ago according to his order and without any promise of rewards. In one village the people were said to have protected their fields with some success by enclosing them with bamboo pieces set up closely and slanting outwardly much in the manner of bamboo hammer traps (*see* Plate 9) used against rats on *taungyas* (hill side plantations). Of course, the bamboos were got simply for the cutting. Under the above conditions any offensive measures, such as are practicable in the Plains and easily accessible areas, were out of the question. Fumigation with the white ant exterminator was imprac-

* This number is evidently exaggerated.—*Editor.*

A Burmese Hammer Rat-trap.

The inclined hammer, a thick heavy green bamboo, is balanced in such a way that it comes down on the rat trying to make its way through the opening and breaks its skull. Two spring traps, one with a rat caught in it, are shown on the left side but are not quite distinct.

ticable even in the field embankments unless they were first of all cleared of the thick growth of tall grasses to enable the holes and their many openings to be located. The rats living here could be more easily destroyed by opening the shallow holes as stated above. Besides, their number was insignificant compared with those living in the surrounding hills. It did not seem that the offer of rewards would lead to the destruction of more rats than was being carried out by the people already who simply wanted to be shown the way how to kill more. The case seemed somewhat like protecting godowns and houses but the conditions were very difficult. The people were afraid to use ordinary poisons for fear of contamination of the sources of drinking water by rats which might come for a drink and die there. The authorities were afraid of undesirable results which might follow unscrupulous use of a poison entrusted to the people and therefore decided on a bacterial poison to be employed. Liverpool virus and Ratin with Ratinin were procured. Both were reported to give satisfactory results in the preliminary cage trials carried out at Leiktho by the Sub-Divisional Officer, Toungoo. The details of the field trails have not yet been received but the reports are not as satisfactory as expected. On the strength of the results of the crab-trapping experiments detailed in the paper on crabs the use of earthen pot traps was suggested but with what result is not yet known. In addition to the above steps the people were of course encouraged to carry on trapping and killing as they were doing. Under similar conditions in Salween district the use of earthen pot traps and barium carbonate, backed up by the prevalent methods of destruction, was recommended. The results are not yet known.

The Man, Mon and Salin canals area in the Plains in the Minbu district are reported to be subject to rat pests which occur after indefinite intervals of years. In bad years in this tract competent authorities state the damage to amount to about 25 per cent. Individual holdings may suffer more. The whole area is quite open and level. The rats are reported to appear about July and begin with picking up the seeds from the seed-beds. They live in holes in the field embankments and continue damage throughout the season, cutting the plants and ears. They disappear after the paddy is harvested.

Although there are waste lands overgrown with grasses here and there bordering this area, there is no place where the rats can increase enormously. It appears that in bad years they migrate from the neighbouring hills.

Here the people dig out and kill the rats. Some put up *thadi* (*i.e.*, a picture of a rat) or *gada* (a sort of a charmed letter calling upon the rats to depart) on a pole in their fields. Some set up dummy figures

to scare them away. Many are destroyed for human consumption, the larger ones selling for half to one-and-a-half annas. Some make it a profession to kill and sell them at the time, large numbers being brought to local markets for the purpose. In the Hill Districts, too, rats are eaten. The writer has had no occasion yet to deal with a rat plague in the Plains. In such cases an organized campaign of destruction aided by earthen pot traps and barium carbonate, is suggested at present.

A number of rat skins were prepared at Leiktho and Mr. Clague made serious attempts to find out if there was a market for them through the Director of Industries. The Assistant Indian Trade Commissioner, London, tried several firms in the United Kingdom and also German and Austrian markets. The skins were considered to be too thin and fragile to be of any value.

Sardar Harchand Singh described a simple type of retort invented by Colonel Lane, P.M.O., Patiala, for fumigating rat-holes with the fumes of sulphur dioxide. Sulphur is burnt on a fire on *bhusa* within a retort over which a current of air is forced from a country goat-skin bellows, such as is used by the village blacksmiths. He stated that the apparatus was cheap and easily constructed, light and portable and had proved extremely effective and popular with the *raiyat*. In some cases considerable numbers of rats were killed in one burrow by the use of this apparatus, as many as twenty-five dead rats having been taken from one hole. He also described poisoning experiments conducted which had proved fairly effective but would not bear comparison with the fumigation method.

25.—RAT DESTRUCTION ON A FIELD SCALE : BAITING AND FUMIGATION.

By M. AFZAL HUSAIN, M.A. (Cantab.), M.Sc. (Punjab), I.A.S., *Entomologist to Government, Punjab, and* KESHO DASS BANERJEE, M.Sc., *Demonstrator, Punjab Agricultural College.*

(Plate 10)

So far, three species of rats have been found causing damage to crops in the Punjab :—

1. *Gerbillus indicus*, which is the most common.
2. *Gerbillus erythrura.*
3. *Nesocia hardwickei.*

(*i*) *Gerbillus indicus* or Antelope rat—tail is longer than head and body ; ears moderate, round ; thinly clad. Eyes are very large. Colour is brownish rufous above and whitish below. Tail is with light brown band down each side, above and below darker, the upper surface becoming blackish and clothed with long hairs towards the end which is tipped with a pencil of long dark hairs almost black.

(*ii*) *Gerbillus erythrura* differs from *G. indicus* in size and colour. It is stouter in form and its burrows always have an open entrance and go very deep down in the soil, sometimes twelve feet or more. The incisor teeth are sharp but not broad and the tail longer than head and body put together. It is heavily furred and its colour is greenish dorsally and whitish ventrally. It has been found in great abundance in Gurdaspur district (Dinanagar and Pathankot).

(*iii*) The so-called Mole rat (*Nesocia hardwickei*) is a ferocious looking animal with sharp broad incisors ; small ears not covered with hairs ; and tail shorter than body. It burrows run horizontally, winding among the bases of the plants in a zig-zag manner. The length of the burrows is variable, depending on the time that a rat has occupied it. At Jharauli (District Karnal) a burrow was traced, and, not taking into account many short branches of it, it ran for about 52 feet. Each burrow has a number of openings and at each entrance a mound of earth, varying from nine inches to 2 feet in height, is found. It is a good swimmer and can swim to safety when fields are watered. The grunting sound that it produces when disturbed gives greater effect to its ferocious appearance. It is never found in houses but occurs in fields in certain parts of the Punjab. It tunnels the whole soil to such an extent that one sinks into the soil

while walking in fields attacked by this rat. We have come across it in Jullundur, Sialkote, Ambala (Jharauli and Bihta) and Gurdaspur (Pakhowal) districts.

Losses.—Rats can subsist on a variety of food plants ; wheat, gram, maize, sugarcane and cotton are some of the main crops attacked. Even fruit trees are not safe from them, particularly those near fields. Whereever they find suitable food, they migrate in numbers and establish themselves so firmly that it becomes difficult to dislodge them. The losses that rats cause annually to crops, fruit trees, etc., are enormous. At Pakhowal (Gurdaspur), wheat, Pusa 12, which is beardless, was severely attacked by mole rats at the time of ripening and a cultivator lost two-thirds of his crop. The rats gnawed the plants at their bases and, after the plant had fallen, took away the ears into their burrows. Some of the holes were dug open and large quantities of ears, from which grains had been removed, were noticed.

At Paharu Chak (Gurdaspur) the devastation caused by this pest was so very great that *zamindars* had thought of abandoning their lands. For the last four years, the yield of their crops had been rapidly decreasing mainly through the ravages of this pest, and last year (1922) even the land-revenue could not be recovered from the produce of this land. The following losses caused in the village during the last Kharif crop speak of the condition of the poor farmers fairly effectively :—

No.	Name.	Crop.	Area.	Estimated yield in maunds.	Value.	Actual yield.	Value.	Net loss.	REMARKS.
1	Sandikhan .	Til	3 *ghumaon.*	12	Rs. 84 at Rs. 7 per *maund.*	8 *seers*	Rs. 1-6-0	Rs. 82-6-0	
2	Do. .	Rice	12 Kenal	10	Rs. 30 at Rs. 3 per *maund.*	20 *seers*	Re. 1-8-0	Rs. 28-8-0	
3	Do.	Mash	3 *ghumaon*	10	Rs. 40 @ Rs. 4 per *maund.*	1 *maund*	Rs. 4-0-0	Rs. 36-0-0	
4	Do. .	Water-melon	3 *ghumaon*	10	Rs. 25-0-0	...	...	Rs. 25-0-0	Given on contract but, there being no yield, the contractor ran away.
5	Nawab .	Do.	8 *ghumaon*	10	Rs. 150-0-0	very little	Rs. 50-0-0	Rs. 100-0-0	

At Jharauli (Karnal) the rats were in great numbers and in the present *rabi* crop (1922-23) wheat has in some cases been sown three times and yet with little success. The following few cases show the losses sustained:

No.	Name.	Crop.	Area.	Estimated yield in maunds.	Value.	Actual yield in maunds.	Value.	Net loss.	REMARKS.
1	S. Gajendar Singh Rais.	Inferior millets	23 *bighas*	80	Rs. 200 @ Rs. 2 per *maund.*	6	Rs. 15-0-0	Rs. 185-0-0	
2	Do. .	*Moth*	125 *bighas*	125	Rs. 750 @ Rs. 6 per *maund.*	25	Rs. 15-0-0	Rs. 600-0-0	

The rats had also brought about the death of many valuable plants such as Malta oranges, mango, etc., by cutting off their roots. Alongside the hedges (which consisted of sarkánda) of the gardens, the mole rat had established itself very firmly and carried out it's devastation from this place to fruit plants.

In November 1922, we received a report of a heavy attack of rats in the Race Course at Ambala, which owing to the abundance of grass around it. was badly infested by mole rats which had made their burrows on the actual course. The condition of the course was so exceedingly bad that it was feared the races would have to be postponed. It is not the loss of grass or smoothness of the Course that matters but cases had been known of valuable horses not only losing the race but fracturing their legs by sinking deep in a burrow during full gallop and injuring the rider by throwing him over. Patent rat exterminators were being used at tremendous cost without any effect. We started the campaign and the course was cleared of this pest in a few days.

Heavy as the above figures are, it surprises one to see such enormous national losses recurring every year. One is almost forced to say that Major Kunhard's estimate of 800 million rats in India, and an annual loss of Rs. 4,56,250,000, as calculated in our last report, seems very much below the actual figures.

Control.—(*a*) *Fumigation.*—In our last report we gave an account of our experiments with poisoned baits.

Since then we have tried poisonous baits and fumigation on an extensive scale. A "Suddeth Rabbit Fumigator" machine (Plate 10), was introduced with much success especially at places where poison could not be used. This fumigator consists of (*a*) double working pump, (*b*) a main drum into which fumigants such as CS_2 and petrol are put, (*c*) attached to (*b*) is an apparatus to hold two bottles, one containing weak HCl and the other ammonia liquid, meant to produce white fumes, (*d*) a rubber tube.

At first smoking fumes are introduced into the burrows to locate all the outlets which are then closed. The fumigant is then pumped in, a few full strokes (5-15) of the fumigant being sufficient to introduce vapours of CS_2 or petrol to every part of a burrow ; the mouth of the burrow is then closed and the rats inside the burrow are sure to die.

This Fumigator has proved very successful, as would appear from the attached statement. We have successfully used it over extensive areas in a variety of conditions. With a pound of CS_2 one can treat about 22 burrows and the cost per burrow amounts to one anna, when CS_2 is sold at Rs. 1-6-0 per lbs. As a *zamindar* works himself in his spare time, his labour has not been calculated. This cost may be little too much

Suddeth Rabbit Fumigator.

Above, view showing details of the machine ; below, effects of its work.

but is easily compensated when one takes into consideration the advantages of fumigation. The latter has the following beneficial points over the poisonous baits :—

(*i*) All the occupants inside are killed by one operation whereas the poison affects only those that eat the poison,

(*ii*) Fumigation is safe as there is no danger of poisoning domesticated animals,

(*iii*) It is a more sure process. Rats in a burrow that is fumigated, must die.

So far we have only tried CS_2 and ordinary petrol.

(*i*) Carbon bisulphide has always been used with very great success everywhere. As will be clear from the statement, some 95 to 97 per cent. of the fumigated burrows remained closed.

(*ii*) Petrol. It is not so very successful in killing rats. Of course it helps a good deal in driving them out from their homes. Experiments were tried to fumigate living rats inside a closed vessel. Sufficient fumes of Petrol were pumped in but after about fifteen minutes they came out as healthy as before.

The only precaution necessary in fumigation with CS_2 in a field is that no light of any kind should be near. Vapours of CS_2 or petrol, which a fumigator must necessarily inhale in small quantities, do not produce any dangerous result. Slight headache after a day's work must be disregarded.

(*b*) *Baiting.*—The use of poison baits was made more extensively at many places and the following proportions gave good results. We have thus been able to reduce the proportion of poison.

I. *Strychnine.*—

Poison . . .	1 *chhatak*	Sufficient for about 1,280 burrows. Cost per burrow 2·1 pies (nearly) @ Rs. 7 per oz.
Sugar . . .	5 *seers*	
Grain . . .	40 *seers*	

Of the treated burrows 80 per cent. remained closed.

II. *Arsenous acid.*—Its efficacy was consolidated and repetition of old formula made—

Poison . . .	4 *chhataks*	Sufficient for about 480 burrows. Cost per burrow ·2 pies @ Rs. 0-12 per lb.
Sugar . . .	1 *seer*	
Grains . . .	15 *seers*	

70 per cent. of the treated burrows remained closed.

III. *Kuchla* seeds (*Strychnos nuxvomica*) were used with much success. The extraction of poison was done by continued boiling and cutting of the seeds into small pieces. The following proportion gave good results.

Poison . . .	$2\frac{1}{2}$ *chhataks*	Sufficient for about 480 burrows.
Sugar . . .	2 *seers*	Cost per burrow ·3 pies @ Rs. 5 per lb.
Grains . . .	15 *seers*	

Percentage of success was 70 per cent.

Although in all our extensive operations we have not seen or heard of any domestic animal dying of poison (except a dove and a wild cat) yet great care must be taken when using poison baits. Poison baits should be kept away from children and domestic animals and, when placed in the burrow, they should be put deep down in the ground. Every morning all the dead rats should be collected and buried deep.

Co-operation.—Rat extermination on an extensive scale is sure to fail if there is no co-operation between the *zamindars* and the Department and when the campaign is not well arranged. No success can be achieved by treating fields individually at different times, for the rats migrate from far and wide and settle down where food is abundant. It is not infrequent to find *zamindars* crying for help against the ravages of this pest but, when it is forthcoming, they become reluctant to supply labour or spend money. At Shahabad and Damali (Karnal) in December last a severe rat attack prevailed. Cotton had been mercilessly spoiled, young grain plants were eaten up and it was feared that wheat would similarly be devastated. *Zamindars* showed willingness to work under organization and to pay its cost. Arrangements were made to take up 4,000 bighas at a time and clear it of the pest, but, when labour and cost of poison were demanded, they forgot their losses and felt inclined to leave it to fate. Most people want Government to pay for the destruction of Vermin, but they do not realise that it is not possible for any Government either to supply funds for this undertaking or engage sufficient staff. Without co-operation nothing can be achieved. It is high time that we followed the example of Denmark and had definite legislation for rat destruction.

We have during the last season treated some 4,375 burrows in 758 *bighas* of land. In one village, Paharn chak, the attack was so severe that the people were ready to fly away before the rats. We took up the campaign and exterminated the pest within seven days. The area under treatment was $226\frac{1}{2}$ *bighas*. All the cultivators were divided into groups; each group consisted of a head man and a number of followers who were chiefly boys. The whole of the land attached to the village,

was similarly divided up into smaller areas and each area placed under the charge of a group. The baits were prepared a day before in the evening and distributed to each group next morning. Before commencing the campaign demonstration was given to all groups as regards the method of putting baits inside a burrow and the head of each group was held responsible for all accidents and neglect of work. Counting of the burrows treated or those that remained closed was to be done by the head of each group. Supervision of the whole work was done by the employees of the Department.

Summary of the operation in the village :—

Area treated	226½ *Bighas*.
Population	about 50 (male and female).
Probable number of rats . . .	about 5,884.
Damage as recorded in *Kharif* crops in few cases	Rs. 271-14-0.
Cost of operation	Rs. 25-9-6.

Rat campaigns were similarly taken up at Mamoon (Gurdaspur) and Kiryal (Montgomery) on extensive scales and a complete success achieved in a few days as given in the statement.

No.	Poison.	Total area.	Irrigation.	Soil Variety.	Kinds of crops.	Total No. of burrows treated.	Average cost per burrow.	Efficacy.	REMARKS.
1	CS_2	30 Bighas	Chahi and Barani.	Sandy and Clay.	Sugarcane wheat and gram.	461	One anna	95-97%	Poison @ Rs. 1-6-0 per lb.
1	Petrol	4 Bighas.	Barani.	Clay.	Grassy plots.	67	4·5 pies.	66%	Poison @ Rs. 2-8-0 per gallon.
3	Strychnine . .	208½ Bighas.	Canal, Chahi and Barani.	Sandy Clay & stony.	Wheat, sugar-cane, Gardens and Barren.	2,173	2·5 pies.	85%	Poison @ Rs. 7-2-0 per oz. Formula— Poison . . . 1 chk. Sugar . . . 5 srs. Grains . . . 40 srs.
4	Arsenous Acid .	488 Bighas.	Do.	Do.	Wheat, cotton, sugarcane and gardens.	1,111	·3 pies.	70%	Poison @ As. 12 per lb. Formula— Poison . . . 4 chk. Sugar . . . 1 sr. Grains . . . 15 srs.
5	Kuchla (Strychnos nux-vomica) seeds.	68 Bighas.	Barani.	Sandy.	Wheat, sugar-cane and Barren.	926	·5 pie.	70%	Poison @ Rs. 5 per lb. Formula— Poison . . . 2¼ chk. Sugar . . . 25 srs. Grains . . 15 srs.

26.—THE GEOGRAPHICAL DISTRIBUTION OF THE COLEOPTEROUS BORERS OF *SAL* (*SHOREA ROBUSTA*).

By C. F. C. BEESON, M.A., D.Sc., I.F.S., *Forest Entomologist.*

This attempt to survey the geographical distribution of *sal* borers was made with the object of finding out (1) how many of the species that attack *sal*, attack also other trees, and to what extent they range abroad; (2) what proportion of the *sal* borer-fauna is restricted entirely to *sal*, and to what extent the species range within the *sal* habitat. Obviously this information is of considerable economic importance.

Shorea robusta is a tree that has a marked gregarious habit, which results in the formation of almost pure forests of large extent. Pure or almost pure forests are not typical of monsoon forests in the Tropics, and for this reason it was expected that the constitution of the *sal* insect-fauna would show the influence of these conditions. The subject is presented at this Meeting in the hope that a comparison may be made between the insect-fauna of a naturally pure crop in its primitive stage of development, and the insect-fauna of cultivated crops under artificially-produced conditions. Consideration has been limited to coleopterous bark-and wood-borers because (1) more is known about them than other groups, and (2) their life-cycles are less susceptible to external conditions than defoliators, etc.

PRESENT DISTRIBUTION OF *Shorea robusta*.

The following account of the distribution of *sal* forests is taken mainly from Troup, *Silviculture of Indian Trees* (1921).

The *sal* occupies two main regions, which are separated by the Gangetic Plain, *viz.*, the northern and the central Indian regions.

In the northern region the extreme north-western limit is in the Kangra district of the Punjab, where there is an outlying area on the west bank of the Beas, in which the growth of the trees is stunted. The main and almost continuous belt of *sal* forest in the north commences with Kalesar forest in the Ambala district, on the right bank of the Jumna, and stretches along the sub-Himalayan zone as far east as the

Darrang district of Assam. In the United Provinces and North Bihar *sal* occurs in the submontane tract, the outer hills, and the adjoining plains in five types of forest classified broadly according to topography, as (1) forests of the hills and narrow valleys, (2) forests of the river terraces, (3) forests of the *duns*, (4) forests of the *bhabar* tracts, and (5) forests of the *tarai* and plains. In the hill forests *sal* ascends to 4,000 feet and exceptionally to 5,000 feet, where it is mixed with *Pinus longifolia*; in the Plains it is still found at a considerable distance from the hills, *e.g.*, in the Tikri forest of the Gonda district.

In Bengal and Assam *sal* forests are of a totally different type to those of the United Provinces owing to the moister conditions. In the Duars occur two types of forests, *viz.*, (1) the high-level or dry type on the *bhabar*, and (2) the low-level or moist type south of the line of springs issuing at the foot of the *bhabar*. South of the Brahmaputra *sal* occurs in the Garo Hills, Nowgong, Kamrup and the Khasi and Jaintia Hills.

In the Central Indian region *sal* commences near the Ganges in the Santal Parganas and extends southwards through Chota Nagpur and the Orissa Feudatory States to the Ganjam district and Palkonda hills of Madras. In Singbhum forests display two types, (1) the valley *sal* occurring on the lower slopes of the deep valleys, and (2) the hill *sal* of poor growth on the upper valley slopes and dry ridges. To the west there are considerable areas of *sal* forest in the Central Provinces, Mandla, Balaghat, Bilaspur and Raipur districts and in Rewah state. The distribution of *sal* in the Central Indian region is governed by soil conditions rather than by climate according to Schimper; it is absent from the western half of the Indian peninsula, where trap is the prevailing rock, whilst it forms extensive forests in the eastern half, which has a very similar climate but more favourable rock-formations.

On the whole, the general distribution of *sal* is governed by climate, while its local distribution is mainly dependent on conditions of rock-formation and of soil. In the northern region its range in the west in the Punjab is limited by deficiency of rainfall and too wide a range of temperature. In the east, in Assam, its occurrence is limited by the high rainfall and humidity, which induces a luxuriant growth of evergreen species and a denser undergrowth, resulting in soil conditions unfavourable for the establishment of seedlings and an unequal competition with shade bearing species.

Within the narrow limits of its present range *sal* formerly occupied a much greater area in localities suitable for it, but it has been much reduced by *jhuming*, shifting cultivation and permanent clearance.

PREVIOUS DISTRIBUTION OF *Shorea robusta*.

Before attempting to discuss the origin of the *sal* borer-fauna it is necessary to inquire if the tree is indigenous in its present habitat, and if the same represents its primitive range. The genus *Shorea* is essentially Oriental with 87 species, of which 3 occur in India, 5 are endemic in Ceylon, 30 in Indo-China, 31 in Borneo, 7 on other East Indian Islands, 7 in the Philippines, 2 from Malaya to Borneo, and 2 from Sumatra to the Philippines. The only fossil remains of the family are a fruit of a species of *Dipterocarpus* occurring in the Kainozoic of Sumatra. The species of *Shorea* are possibly capable of reduction, but their habitats would appear to be small and well-defined.

Evidence of the existence of *sal* forests in historical times is extremely scanty, but it appears to be certain that they have varied in extent with changes in the density of population in the Gangetic plains. In Northern India the primeval forest has not decreased gradually with the advance of civilisation, as it did in Europe, but has experienced periods of destruction and regrowth. The following illustrations of conditions in more recent periods may be taken to represent what occurred before the age of primitive Buddhism, when cities and temples existed where forests occur today.

With the decline of the long-established kingdom of Magadha or Bihar before the third century A.D., and the movement of the subsequent Gupta dynasty from Bihar and Oudh westwards to the Doab and Malwa in the fourth century A.D., the greater part of Eastern India passed into the hands of the aborigines. The ancient capitals fell into ruins and the forest spread once more over the formerly densely populated plains. Forest extended from the Himalayas to the neighbourhood of Benares; the north of Oudh was a forest country; another great forest south of the Ganges extended from Bihar to Rewah, and there were famous forests in the Upper Doab and the neighbourhood of Thanesar.*

It appears probable from incidents in the chronicles of the earliest Arab invasions of India, that the lost river of the Punjab (the Ghaggar?) carried a considerable body of water as late as the beginning of the 11th century; but it no longer flowed in the 13th century.†

In the period of the Muhammadan kingdoms of Northern India, from about 1200-1500, a wide strip of country at the foot of the Himalayas from the Jumna, through Rohilkhand, Oudh, and Bihar was little inhabited and only partially explored.‡

* Imperial Gazetteer of India (1908), II, p. 304.
† Oldham, Qr. Jl. Geol. Soc., Lond., LXXV (1919), p. 157.
‡ Imperial Gazetteer of India (1908), II, p. 356.

According to Benskin* the Etawah district was once covered with *sal* forests, and many villages are named after the tree, *e.g.*, Sakhi, Sakrauli, Sakhua, Sakhopur. In this neighbourhood the bed of the Jumna is known to have been lowered 60 feet in the last 500 years.

In the sixteenth century the Indian Rhinoceros (*R. unicornis*), which is now confined to Assam and the Nepal *tarai*, occurred as far west as Peshawar and was hunted by the Emperor Babar.† A specimen from Cambaya (*i.e.*, Guzerat) was sent in 1514 as a present to the King of Portugal.‡ Babar also mentions wild elephants as abounding in the neighbourhood of Karrah and Mankipur near Allahabad and Kalpi on the Jumna, although two centuries previously these localities were among the most populous in India.§

Such historical records are not quoted to show the permanence of primeval forest, or even savannah lands, but to illustrate the frequent fluctuations in the phytogeographic conditions of the Gangetic plain, that have occurred during the early history of Northern India. One may see to-day the processes by which *sal* takes possession of new areas, and becomes the climax-formation of the locality, for many of the existing *sal* forests have arisen on areas formerly under cultivation. In hilly regions it appears in progressive succession to *Ougeinia dalbergioides*; near rivers in succession to dry mixed forests: and near *phantas, tappars*, etc., natural reproduction advances in competition with grasses. Some of the *sal* forests of the Duars originated on burnt savannah lands, possibly with an intervening stage of deciduous forest. The climatic climax vegetation of the upper Gangetic plain is considered to be a typical deciduous monsoon forest, resembling those now existing adjacent to the Himalayas in the north, and the Vindhias in the South.‖

It may be safely assumed that *Shorea robusta* has occurred at various periods in sufficient abundance to permit the spread of *sal* insects in a north and south direction, and that links have existed, if intermittently, between the submontane belt and the region of Central India. An apparently powerful factor in the distribution of borers from west to east lies in the river-system of the Ganges and its tributaries; and from east to west in the Brahmaputra river. Trees uprooted in the upland ravines by the first floods of the rainy season are carried downstream and stranded in lower reaches where they may be attacked by borers.

* Benskin, Afforestation in the U.P. (1921), p. 8.
† Imperial Gazetteer of India (1907), I, p. 231.
‡ The Book of Duarte Barbosa (1918), I, p. 124, Hakluyt Society, II, XLIV.
§ Elphinstone, History of India (1839), 9th edition, 1905, p. 478.
‖ Dudgeon, Jour. Ind. Bot., I (1920), p. 321.

Later freshets pick up stranded logs and carry them on further to deposit them under conditions that permit the development and emergence of the adult insects. A log infested with longicorns or shot-hole borers may yield a steady emergence of beetles for a whole year in sufficient quantities and at times appropriate for the establishment of the species in new localities.

That the extension of the species may proceed upstream from such foci is equally probable, by means of dead and dying trees afforded by erosion during floods, even if no other means of production of suitable breeding-material is postulated. By these methods of dispersal it should be possible for all species of borers originating anywhere in the drainage area of the Ganges and Brahmaputra to extend throughout these river systems. (The Mahanadi river may be left out of consideration for the present). If facilities for dispersal were the chief factors governing the distribution of *sal* borers, we should expect to find all polyphagous species equally distributed throughout the habitat of *sal*. The data now available indicate that there is a marked differential distribution, so that other and more powerful factors must be considered.

THE BORER FAUNA OF *Sal*.

The Scolytidae (18) and Platypodidae (10) of *sal* amount to 28 species. Of these 9 extend from the Malay Archipelago into India, 7 of them being wide-spread. Eleven species are found in Indo-China, 27 in Assam and Bengal, 16 in the submontane tract of the United Provinces, 12 in Central India, 7 in Ceylon and South India. Seven species occur outside the Oriental Region, 2 of them in Japan, and the remainder in Africa or the Seychelles. The bark-beetle and shot-hole borer fauna of *sal* thus consists of (*a*) wide-spread species, (*b*) Malayan or Indo-Chinese species extending into part of India, (*c*) endemic species confined to Assam and Bengal, and (*d*) species coincident with the *sal* habitat.

The species that one may regard as typically *sal* insects, that is, species of which the range is the same as that of *sal* and of which *sal* is the essential food-tree, are only two in number, or 7 per cent., *viz.*, *Sphaerotrypes siwalikensis* and *Diapus furtivus*. The ecology of these species will be discussed further on.

A remarkable feature of the scolytoid association of *Shorea robusta* is the scarcity of true bark-beetles. Only one species, *Sphaerotrypes*, is a true bark-beetle, and the remaining 27 are ambrosia beetles, *i.e.*, shot-hole and pin-hole borers living in clean tunnels bored deep in the sapwood. In north temperate regions true bark-beetles predominate and ambrosia beetles are in the minority. Saalas records 32 species

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THE BORER FAUNA OF SAL.

1. SCOLYTOIDEA.

—	Malaysia.	Indo-China and Siam.	Burma.	Sal Habitat.							Bombay.	S. India.	Ceylon.	Extra Oriental.
				Assam.	Bengal Duars.	Submontane U. P. and Siwaliks.	Gangetic Plain.	Chota Nagpur & Orissa.	Rehwa and C. P.	Ganjam Vizagapatam.				
SCOLYTIDAE														
Eccoptopterus sex-spinosus	×	—	×	×	×							×	×	×
Sphaerotrypes siwalikensis				×	×	×	×	×	×					
Webbia pabo						×	×							
Xyleborus andrewesi					×	×	×	×			×	×	?	×
X. bicolor				×	×	×								×
X. bicolor, var.				×	×									
X. fallax			×	×	×	×	×	×	?					
X. glabratus					×									×
X. laticollis				×	×	×			?		×			
X. major				×	×	×								
X. parvulus	×	?	×	×	×	×	×	×	×	×	×	×	×	

X. perforans	×	×	×	×	×	×	×	×	×	×	×	×	×	×
X. perparvus					×									
X. recidens					×									
X. schlichii				×	×									
X. semigranosus	×		?	×	×	×	×	×	×			×	×	×
X. turbineus					×			×						
X. undulatus					×									
PLATYPODIDAE														
Crossotarsus bonvouloiri	×	×		×	×									
C. saundersi	×		?	×	×	×	×	×	×			×	×	×
Diapus furtivus				×	×	×	×	×	×					
D. sp. nov. (near *furtivus.*)				×	?	×								
D. 5-spinatus	×		×	×	×			×						
Platypus cupulifer				×	×									
P. curtus	×		?	×	×									
P. curtitus				×	×									
P. solidus	×	×	×	×	×	×	×	×	×	×	×	×	×	
P. sp. nov. (near *uncinatus.*)			×	×	×	×	×							
TOTALS	9	8?11		27		15?16		12				7		7

of bark-beetles and one ambrosia beetle for the spruce (*Picea excelsa*) in N. Europe, and Asia.* Hopping records 18 bark-beetles and 3 ambrosia beetles in *Pinus ponderosa*; and 21 bark-beetles and 1 ambrosia beetle in *Pinus contorta* of the Pacific Coast and the Rocky Mountains†. Chamberlin gives 15 bark-beetles and 5 ambrosia beetles for *Pseudotsuga taxifolia*, the Douglas Fir.‡ Coulon gives 7 bark-beetles and 8 ambrosia beetles for oaks in France.§

I am inclined to consider that the higher proportion of ambrosia beetles to bark-dwelling beetles among the Scolytoidea of the Tropics is due to the greater competition for space among corticolous species of various families. The preponderance especially of the larger longicorns may account for the relatively successful development of ambrosia beetles; since these by their more extensive and deeper larval galleries curtail or obliterate the work of the scolytid bark-beetles. The latter require no bark space except a narrow entrance tunnel which can be re-bored and kept open if over-lapped by the galleries of Longicornia, Buprestidae, etc.

The Longicorn fauna of *sal* comprises 22 species, *i.e.*, 17 Cerambycidae and 5 Lamiidae. Saalas records 21 species of Cerambycidae and 5 species of Lamiidae from Spruce in Europe and N. Asia. Blackman bred out 6 species of Cerambycidae and 1 of Lamiidae from American Larch.|| These proportions are rather interesting in view of the fact that in the Oriental Region the Lamiidae are more numerous (nearly double) in species than are the Cerambycidae. Wallace has pointed out that "the immense superiority of the Tropics in the number and variety of their timber trees, and the extent of their forests, sufficiently accounts for their superiority to the Temperate regions in the development of Lamiidae."¶ As *Shorea* is an endemic Oriental genus one would expect to find a preponderance of Lamiids.

Of the 22 species, half occur in Malaysia, 15 in Indo-China, 19 in Assam and Bengal, 19 in the submontane Himalayas and Gangetic Plain, 12 in Central India, 8 in South India and Ceylon and 4 are extra-Oriental. The longicorns of *sal* are thus mainly wide-spread or intrusive species. There are however a few endemic species known from only

NOTE.—In the distribution tables, × = *known occurrence*, and ? = *probable occurrence* in the region indicated by the column in which the cipher is placed. The records are based on literature or on specimens seen by the writer.

* Saalas, Die Fichtenkafer Finnlands, Ann. Acad. Sci. Fenn., A, VIII, (1917).

† Hopping, Coniferous hosts of Ipidae, Canad. Ent., LIV. (1922).

‡ Chamberlin, Bark-beetles infesting the Douglas Fir, Oregon Agric. Coll. Expt. Sta. Bull. 147. (1918).

§ Coulon, Les insectes du chêne, Bull. Soc. Sci. Nat. d'Elbeuf. (1917).

|| Blackman, Insects bred from Bark and wood of American Larch. New York Sta., Coll. For., Syracuse, Tech. Pub. No. 10 (1918).

¶ Wallace. the Geographical Distribution of Animals, (1876), Vol. II, p. 999.

2. LONGICORNIA

LONGICORNIA.	Malaysia.	Indo-China and Siam.	Burma.	Assam.	*Sal Habitat.* Bengal Duars.	Submontane U. P. and Siwaliks.	Gangetic Plain.	Chota Nagpur and Orissa.	Rewa and C. P.	Ganjam Vizagapatam.	Bombay.	South India.	Ceylon.	Extra Oriental.
CERAMBYCIDAE														
Aeolesthes holosericea	×	×	×	×	×	×	×	×			×	×	×	
Ceresium leucosticticum	×	×	×	×		×	×		×					
C. nilgiriense			×		?	×	×		?			×	×	
C. zeylanicum	×		×	×	×	?			×				×	
Chlorophorus annularis	×	×	×	×	?	×	×		?			?		×
Chlorophorus sp. nov. 1					×									
Chlorophorus sp. nov. 2						×								
Dialeges pauper	×		?	×	×	×	×							
Diorthus cinereus	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Epipedocera affinis						×	×		?		×	×		
Epipedocera zona					×	×	×							
Euryphagus lundi	×		×	×	×									
Hoplocerambyx spinicornis	×		×	×	×	×	?	×	×	?				?
Nyphasia apicalis						×		×			×			
Perissus mutabilis		×	×		×									
Xylotrechus buqueti	×	×	×	×	×	×								
Xylotrechus smei				×	×	×	×	×	×		×			
LAMIIDAE														
Batocera rubus	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Coptops aedificator	×		?		×	×	×	×	×				×	×
Coptops leucosticticum				×	×	×								
Mesosa (Cacia) cretifera		×	×	×		×								
Monohammus bimaculatus		×	×		×	×								
TOTALS	11	13?15		17?19		19		10?12				8		4

a part of the *sal* habitat, but none whose distribution is entirely coincident with that of the host. *Hoplocerambyx spinicornis* extends from the Malay Archipelago into India, but in India is apparently restricted to the *sal* area and to *sal* as a food-tree, except for the small tract in Assam inhabited by *Shorea assamica* In the dryer parts of the *sal* area in the Gangetic Plain, the hill forests of Orissa and the Central Provinces, it is rare or absent, being generally replaced by *Œeolesthes holosericea.*

Bostrychidae. Nine species of this family occur commonly in *sal* wood in the forest or in timber depots. (Other species, typical dry wood-borers, occur in seasoned lumber and constructional timber). Seven are wide-spread species, one extending from the Red Sea coasts throughout India to the dryer parts of Burma, and the rest occurring throughout India and into the Malay Archipelago. Two species of *Sinoxylon* are known at present from part only of the *sal* habitat, but their areas of distribution are wider, *viz.*, S. India and Ceylon in the case of *atratum,* and Kashmir and the Punjab in the case of *capillatum.* The two species proper to India belong to a group of six very closely allied forms with relatively restricted habitats.

All the Bostrychidae found in *sal* are known from other hosts and, as members of this family are normally polyphagous, *sal* may be considered as one of the possible food-trees without special preference.

Of Anthribidae, Brenthidae and Curculionidae only a few species are known, or at any rate identified. These are either endemic or extend from Malaysia and Indo-China.

Summarising the distribution of the species of borers in the foregoing families, we have—

	Malaysia.	Indo-China.	Assam and Bengal.	Submontane and Plains.	Central India.	S. India and Ceylon.	Extra Oriental.
Scolytidae .	9	8 ? 11	27	15 ? 16	12	7	7
Longicornia .	11	13 ? 15	17 ? 19	19	10 ? 12	8	4
Bostrychidae .	6	7	7	9	8 ? 9	8	8
Other families .	1	2 ? 3	7	7	1 ? +	0	0
TOTALS .	27	30 ? 36	58 ? 60	50 ? 51	31 ? 34+	23	16
% age.	45	60	100	85	57	38	27

BOSTRYCHIDAE	Malaysia.	Indo-China and Siam.	Burma.	Assam.	Sal Habitat. Bengal Duars.	Submontane U. P. and Siwaliks.	Gangetic Plain.	Chota Nagpur and Orissa.	Rewah and Central Provinces.	Ganjam Vizagapatam.	Bombay.	South India.	Ceylon.	Extra Oriental.
1. *Heterobostrychus aequalis*	×	×	×	×	×	×	×	×	×	×	×	×	×	×
2. ,, *hamatipennis*	×	×	×	×	×	×	?		?		?	×	×	×
3. *Schistoceros anobioides*			×	×	×	×	×	×	×	?	×	×	×	×
4. *Sinoxylon anale*	×	×	×	×	×	×	×	×	×	×	×	×	×	
5. ,, *atratum*						×		×			×	×	×	
6. ,, *capillatum*						×	×	×						
7. ,, *crassum*	×	×	×	×	×	×	×	×	×	×	×	×	×	×
8. *Xylodectes ornatus*	×	×	×	×	×	×	?		?		×	×	?	
9. *Xylothrips flavipes*	×	×	×	×	×	×		×			×	×	×	×
TOTALS	6	7		7		9		8?9				8		5

					Sal Habitat.									
	Malaysia.	Indo-China and Siam.	Burma.	Assam.	Bengal Duars.	Submontane U. P. and Siwaliks.	Gangetic Plain.	Chota Nagpur and Orissa.	Rewah and Central Provinces.	Ganjam Vizagapatam.	Bombay.	S. India.	Ceylon.	Extra Oriental.
CURCULIONIDAE														
Rhadinomerus diversipes				×	?	×								*
Phaenomerus sundewali			×	×	×	×	×	×			×			
Phaenomerus brevirostris				×	×	×								
	0		1	3		3			1		0			0
BRENTHIDAE														
Suborychodes intermedius			?	×	×	×								
ANTHRIBIDAE														
Ozotomerus maculosus				×	×	×								
Physopterus agrestis					×	×	×							
Litocerus paviei		×	×	×		×	×							
	0	1		3		3			0			0		

The borer association of *sal* is thus made up of the following elements : (*a*) species pre-eminently monophagous (*i.e.*, typical *sal* insects) distributed throughout the habitat of *sal*, *e.g.*, *Sphaerotrypes siwalikensis*, *Diapus furtivus*.

(*b*) species found in part only of the *sal* habitat and known only from *sal*, *e.g.*, *Xyleborus recidens*, *Webbia pabo*,

(*c*) species found in part only of the *sal* habitat but also outside or in other host-trees, *e.g.*, *Platypus curtus*, *Epipedocera zona*,

(*d*) species of wide distribution, and a variety of hosts found throughout the *sal* area, or the greater part of it, and beyond, *e.g.*, *Platypus solidus*, *Heterobostrychus aequalis*.

The last class, the wide spread species, may be dismissed, as their distribution is not influenced by factors peculiar to *sal* forests. The ecological conditions affecting their existence are of more common occurrence.

Classes (*c*) and (*b*) should probably be grouped together ; they represent species whose principal food-tree is a species other than *sal*. The fact that some of them, class (*b*), are known only from *sal* may be the result of insufficient collecting. If these species were monophagous and *sal* their host-tree, then, in accordance with the conditions recounted above, their distribution should be coincident with that of *sal*. The majority of the species of classes (*b*) and (*c*) range from the Malay Archipelago or from Indo-China into the *sal* forests of Bengal, but not beyond. Evidently in the Bengal forests there exists an ecological barrier, which limits the range of the eastern species.

Presumably this barrier is the result of rainfall and its indirect affects, but it is not clear how external climatic conditions can seriously affect the development of borers living in the relatively stable environment of green timber. It is true that in the evergreen forests of Assam there exists a much richer fauna of Platypodidae and wood-boring species of Scolytidae than elsewhere in India, except possibly the Western Ghats ; but that may be as much due to the greater number of tree species constituting the forests, as to the higher atmospheric humidity, that prolongs the drying-out of fallen timber. Apparently one should conclude that *Shorea robusta* is not the primary food-tree of those endemic and foreign species that attack it in Assam and the Bengal Duars ; that it is not the nutritive value of *sal* bark or *sal* sap-wood, that determines their presence, so much as the physical conditions due to different rates of seasoning.

It would also appear that these species are not able to produce strains with an intensified preference for *sal*. As Craighead* has discovered, continued breeding in a given host intensifies the preference for that host, but at the same time the condition of the host at the time of attack has a great influence on its selection. A strain of a polyphagous species after continued development in one host may choose a new host in the optimum condition for attack in preference to the old host in which conditions are unfavourable.

Referring again to the table given on p. 168 we see that the maximum number of species feeding on *sal* occurs in Bengal and Assam, about 80 per cent. of the number occur in the sub-montane zone and about 50 per cent. in the Central Indian region. Each of the two last regions has a few peculiar species not found in Bengal. It is evident that the composition of the borer-fauna of *sal* at any part of its habitat is a function of the locality, that is to say, the ecological conditions of the environment are of greater importance in deciding what species of borers will occur, than is the presence of *sal* as a food-supply. One would probably find the same proportional distribution of species within the *sal* area in any large group of insects, *e.g.*, butterflies.

As Pagenstecher points out with regard to butterflies, the distribution of a plant species usually extends far wider than that of a caterpillar feeding solely on it. The non-monophagous species are not restricted to the particular locality of one plant species, but tend to occupy particular plant-formations. There is no absolutely fixed relationship between the plant, and the insect species of which it is the host.† As far as I have been able to discover, this appears to be the general rule for plants and insects in the natural state of distribution.

It is perhaps idle to speculate why or how this can be from the *data* now available, but there appears to be a factor that may explain the distribution of associated species, and that is their relatives ages. According to the hypothesis that has been built up by Willis, Guppy, and others, and is known by the formers phrase, Age and Area,‡ the longer a group of allied species has existed, the greater the area it will occupy. On an average the oldest species of such a group of close allies will occupy the widest areas, while the youngest species will exhibit the smallest ranges. Dispersal is considered to be mainly mechanical, since the vital factors usually referred to as natural selection, or " the struggle

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* Craighead, The Hopkins Host-selection principle as related to certain Cerambycid Beetles., Jour. Agric. Res. XXII, 1921, p. 219.

† Pagenstecher, Die geographische Verbreitung der Schmetterlinge (1909) pp. 18, 19.

‡ Willis, Age and Area (1922).

for existence," act at a more or less uniform rate on all allied species. In the case of the insect fauna of *Shorea robusta* conditions exist under which the effect of age may show itself.

The differentiation of the present species of *Shorea* must have occurred in Ceylon, India and Burma before the Pliocene period. The latest ideas on the evolution of the drainage of northern India suppose that a river existed in Pleistocene times which flowed from Assam to the Punjab, probably finding an outlet to the sea along the course of the present Indus.* A combination of tectonic movements, and cutting-back by the rivers flowing southwards from the water-shed of the Rajmahal-Shillong hills, caused the upper reaches of this ancestral river to be captured and diverted to the area now occupied by the Bay of Bengal. The flow of the river in its westward section was gradually reversed, and its tributaries captured to form the present Ganges. Thus, the stabilising of conditions following the reversal of drainage, with the consequent evolution of the Ganges and lower Brahmaputra, and the deposit of the Indo-Gangetic alluvium, concerns only the recent period. The later stages of adjustment would seem to have extended even to the historic period. The Mahanadi river is a far more ancient river, that was betrunked in its lower course by the extension of the sea after the Pliocene. The fact that the aquatic fauna of the Indus and the Ganges is similar in many respects, *e.g.*, the dolphins and the Chelonia, while differing in these respects from that of the Mahanadi and Irrawaddy, shows that species could have pre-existed and continued from Pleistocene times. On the other hand the scarcity of endemics in the *sal* habitat, *i.e.*, of essentially *sal* insects, would suggest that time has been insufficient for their evolution. In the case of the genus *Diapus* we have a group of species that appears to have evolved on the lines formulated by Willis. *Diapus 5-spinatus* is the most wide-spread species (New Guinea-Ceylon-Bengal) and presumably the ancestral form. There appears to be a zoocentre in the Himalayas and the sub-montane zone, where a number of species of small and overlapping ranges occurs. *Diapus furtivus* finds its nearest relatives in *D. impressus* of the N. W. Himalayas and a new species extending from the Siwaliks to Assam. If *D. furtivus* is older than these two they must be of quite recent age. *Sphaerotrypes siwalikensis* belongs to a genus of much wider area than that of *Diapus* and is a species differing very considerably from its congeners. Its closest relative occurs in N. Burma. Here again we may consider the evidence to indicate youth.

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* Pilgrim, Jl. & Proc. As. Soc. Bengal, XV. (1919), pp. 81-100. Pascoe, Quart. Jl. Geol. Soc. Lond., LXXV, (1919) pp 138-155.

Beyond this stage of speculation it is unprofitable to proceed, for if the endemic borer-fauna of *sal* is as young as it appears to be, I am unable to understand why the evident methods for dispersal work so feebly.

In putting this subject before you I am anticipating the criticism of being too previous. The subject of geographical distribution requires an abundance of facts before it yields a fragment of information on which one can erect an hypothesis, but I do not think we can postpone too long the putting on record of distributional *data*. Now-a-days natural dispersal is being nullified by artificial or human agencies. Several S. American species of Bostrychidae were introduced from W. Africa during the slave-trading days and are now a part of the permanent fauna. During the War the transport of species of timber-boring insects to new localities was extraordinary. England has received several new species, some of which are established. Mesopotamia received quantities of green timber from which borers emerged, a long way up-river, but of course died out. East Africa must have exchanged species with India. Our chances for the study of undisturbed primitive conditions, to explain the original relationships of a plant and its associated fauna, appear to be disappearing rapidly, even in the Tropics.

Thus that most important timber tree, the teak, has wandered far from its original habitat. On historical, etymological and phyto-geographical grounds there is strong reason to believe that teak is not indigenous in Java, but has been introduced there as elsewhere in the Malay Archipelago, by mediaeval traders. Kalshoven* has suggested applying the geographical distribution of teak insects to the solution of the problem, but without obtaining any light. As the insect fauna of teak is less well known than that of *sal*, this is not surprising.

Mr. Fletcher. Mr. Beeson's paper is so full of philosophical meat that it is difficult to remark on it in any detail. His reference to the distribution of boring beetles in logs carried downstream by rivers in India, coupled with his remark regarding the extension of at least one Indian Scolytid species to the Seychelles, however, reminds us that such a means of dispersal, perhaps normal within the limits of a river system, has also possibilities of a more extended nature in connection with the distribution of such insects by means of floating logs carried by marine currents. When I was working in 1905 at the Insect Fauna of some of the islands in the Indian Ocean, I remember finding a large log stranded on the beach of a small islet, little more than a sand-bank, and in this log were several

* Kalshoven, Tectona XV, 1922, pp. 788-791.

living wood-boring beetle larvae which had evidently survived such a marine passage. Such a case of successful transport must occur very rarely, but, even so, it certainly is an appreciable factor in the distribution of species. As regards Mr. Beeson's remarks about an ecological barrier between Bengal and the country further West, we have an excellent example in the case of the Mango Fruit Weevil (*Cryptorrhynchus gravis*) which occurs commonly in mango fruits in Bengal but which has never been found in Bihar, although there is a continuous distribution of the foodplant between the two areas and also a continuous distribution of the insect in affected fruits and it would seem *prima facie* probable that an insect which passes its early stages in a protected situation within the fruit would be very little affected by climatic conditions. As regards Mr. Beeson's remarks about the richness of the Scolytid and Platypodid fauna in Assam, this is paralleled in other groups of insects and seems to be due to the fact that Assam is a meeting-place of several distinct faunal areas, the Palaearctic on the North, the Indian on the West, and the Burmese on the East, whilst there is also a distinct Malayan intrusion from the South, and pronounced affinities with Ceylon. The jungle flora is also very rich and mixed, and the profusion and variety of plant food has led to a corresponding richness of insect life in the Assam Hill Districts.

27.—RECENT WORK IN FOREST ENTOMOLOGY (ABSTRACT).

By C. F. C. BEESON, D.Sc., F.E.S., *Forest Entomologist.*

An account was given of the progress in investigations in Forest Entomology carried out by the Forest Research Institute, Dehra Dun. The major subjects under research are concerned mainly with the borers of Indian timbers. A general survey has been made by visits to different types of forests in various parts of India and Burma, by records made at experiment stations, where the natural seasoning of timbers is being tested, and by breeding work carried on in the Insectary at Dehra Dun.

Much information has been collected on the food-habits and distribution of the borers, and on the conditions under which the timbers are liable to attack. One of the most important results has been the discovery of numerous species of borers, that normally develop in the living tree, without killing it, or appreciably injuring the living tissues. The borers of this class are members of the families Cossidae, Hepialidae, Cerambycidae and Lamiidae. The recognition of the prevalence of this form of damage has permitted a more correct interpretation of the success or failure of seasoning experiments.

A consideration of the ecological succession of borers throughout the year has suggested that periods exist, during which trees may be felled or girdled with the least expectation of injury to the timber; and that, in cases where attack by borers is inevitable at all periods of the year, it is feasible to invite the attack of surface and sapwood-inhabiting species in order to prevent the subsequent establishment of more injurious heartwood borers.

An account of the different classes of boring insects and of the damage caused by them has been published in *Indian Forest Records*, IX, V (1922) "Further experiments in the air-seasoning of Indian timbers and general recommendations as to seasoning methods."

Work on the subject dealt with above has been carried through mainly in the Insectary and seasoning Depots. Work on the life-histories of borers carried out in the forest was illustrated by two examples.

The beehole borer of teak, *Duomitus ceramicus,* received attention from an officer appointed to one of the posts of Divisional Forest Entomologist, but for various reasons he was able to investigate the problems for less than five months. Work consisted in a determination

of the local incidence of the borer in various parts of the teak zone in Burma, by means of the stem analysis method devised by Beeson, and described in *Indian Forest Records*, VIII, iii (1921). The data are expressed in indices based on the girth (breast-height) and age of plantations and natural forest trees. The annual incidence records obtained by dating the beeholes now extend back for more than a century. The results obtained amplify those previously published and confirm the principal conclusions that (1) the beehole incidence in equal-aged stands is proportional to the girth, although very fast grown trees may pass the critical figure for the girth-beehole incidence; (2) the annual incidence shows marked fluctuations especially in earlier decades, but the general trend is towards a slight increase, *i.e.*, the periodic mean annual increment is very low; (3) the absolute numbers of the insect are surprisingly small, as when compared with most "pests" it is from a collector's point of view a rare insect.

While no remedial measures beyond the sylvicultural rules already advocated can yet be suggested, it is considered, in view of the marked variation in local abundance, that powerful natural control factors exist and remain to be discovered. Mr. Mackenzie's report is published as *Burma Forest Bulletin* No. 7, Entomological Series No. 1 (1923).

Work on *Hoplocerambyx spinicornis*, the large heart-wood borer of *sal*, was described, and attention drawn to the difficulty of proving the value of control measures when carried out on a large scale. The epidemic of this species has been running since 1916 and has killed some 80,000 trees in a forest of about seven square miles in extent. Control measures were not adopted by the Department until the season of 1921, and their effect is not evident at the present time in the current returns for the yield of timber. A chart was exhibited showing graphs for (1) the annual outturn of trees marked as attacked by the borer, (2) the annual mortality of trees, and (3) the annual rainfall. A close correlation was found between the annual rainfall and the annual mortality up to the point at which control measures were instituted, after which the mortality decreased abnormally. From information obtained by insectary experiments on the metabolism of the borer it is concluded that the activity and reproduction of the beetle (and hence the dangerperiod for fatal attack on trees) is influenced by the atmospheric humidity and extent of precipitation during the Rains. This influence is such that a year of low rainfall serves as a natural reduction of the incidence of the borer and a year of rainfall above the average permits an increase in its numbers.

Sample plots carried on annually over 400 acres of forest show that the mortality of trees is a true index of the abundance of the borer in

the previous year, and permit the interpretation of the success or otherwise of control measures. The control of *Hoploecrambyx spinicornis* is now a practical proposition, for the value of a bored *sal* tree is eight annas against Rs. five to twenty for a sound tree. The Annual Reports of the Forest Research Institute for 1920-21 and 1921-22 contain summaries of the results achieved.

It is extremely interesting to hear about the behaviour of Forest insects, as, although many pest insects are confined either to Forest or Agricultural products, there are frequent cases in which an insect is common to both. And even if this were not so, the knowledge gained in the study of such problems as are presented by the borers of *sal* must be of great use in the study of parallel problems in Agricultural Entomology. For instance, in Kodaikanal we have a species of *Phassus* which bores rose stems, making a long burrow large enough to admit a human thumb. Of *Xylotrechus* also, we have one species in which we are interested, *X. quadripes*, a pest of coffee in South India.

In support of Mr. Beeson's conclusion upon the habits of Brenthidae, I may mention that in Coorg I have seen a number of these beetles in dead wood under suspicious circumstances, and the only conclusion I was able to draw from their behaviour was that they were predaceous.

I would remark that the record of the occurrence of *Duomitus ceramicus* in Sikkim is almost certainly based on erroneous determination. In view of the fact that *Duomitus* must certainly lay a very large number of eggs, probably many hundreds, the larval population of an attacked area is so small as to suggest that there is some unknown factor exercising considerable control. Are the eggs attacked by egg parasites?

It is not known, as so far the eggs have not been observed in nature.

I have occasionally observed a species of Brenthidae in connection with a mixed attack of shot-hole borers in scorched *Hevea braziliensis* trees on rubber estates in Malaya. From the behaviour of the Brenthids, which were seen to move from one borer hole to another, I suspected these insects of robbing the rightful owners of their burrows, for their own oviposition. The possibility of predaceous or inquiline habits also was present. Mr. Beeson's observations of their predaceous habit appear to settle the point, as far, at least, as some species are concerned, and definitely to remove those beetles from the category of injurious to that of beneficial insects.

It sometimes happens that fire spreads among the fallen leaves in rubber estates, scorching the bark up to six or eight feet from the

ground; within four or five days such trees are attacked by a mixed lot of borer beetles which swarm around the trees, and which must, in some cases at least, have crossed considerable intervening areas of healthy cultivation in moving from the old breeding places to the new. It would appear that the attracting influence must be chemotropic, the insects sensing the injured bark from a distance. If this is so, it should of course be possible to trap the borers by the aid of artificially reproducing the attractive material. Can Mr. Beeson tell us if any work has been done upon these lines in connection with shot-hole or other beetle borers of timber?

It is not known what attracts the borers to injured or felled trees. It may be the smell of decomposition. In sylviculture the principle of interposing barriers is employed to prevent the spread of boring beetles. Felling plants are arranged so that each year's felling will be as far away as possible from that of the previous year. Thus there is interposed between successive fellings as wide a barrier of healthy forest as can be arranged.

The degree of attraction varies with locality. Thus felled or burnt trees in moist or tropical forest are quickly attacked, whereas in temperate forests the beetle attack in recent felling is much lighter. I have seen trees in tropical forest with the wood charred an inch deep, and shot-hole borers endeavouring to enter through the charred layer. But after the big incendiary fires of 1921 in the coniferous forests of the Himalayas there was no marked attack of shot-hole borers in the burnt trees.

28.—THE BIONOMICS OF THE SARCOPTIC MANGE PARASITE OF THE BUFFALO, WITH SOME OBSERVATIONS CONCERNING THE RELATIVE POWER OF RESISTANCE TO ADVERSE CONDITIONS OF THE DIFFERENT STAGES OF THE ACARUS AND OF ITS EGG.

By T. M. TIMONEY, M.R.C.V.S., *Third Bacteriologist, Muktesar.*

(Plates 11—14.)

INTRODUCTION.

The two common forms of parasitic mange, *viz.*, the *sarcoptic* and the *psoroptic*, attack large numbers of buffaloes used in Muktesar for serum production during eight or nine months of the year. From May till August the disease disappears; but towards the end of the latter month it makes its reappearance simultaneously in different parts of the station. Since March of last year I was engaged in investigations relating to the sarcoptic Acarus, and except in the course of the few months already referred to, abundant mangy material could be easily procured at any time. A few weeks before the end of the monsoon season, the disease, which had been in a state of abeyance for at least three months, again became manifest in buffaloes which were accommodated in *kraals* widely separated from each other. The outbreak in each *kraal* was apparently spontaneous.

In scrapings taken from large numbers of buffaloes it was usual to find both species of parasites; most frequently the sarcoptic parasite was predominant, but cases occurred in which psoropts were the prevailing species. About ten per cent. of the total cases displayed infection with sarcopts only; but no instance of a pure psoroptic infection came under my notice. The range of movement of the latter is much more restricted than that of the former. In this respect both parasitic forms correspond with their equine counterparts. Each form shows a predilection for the perineal region and the upper thigh (Plate 11). On the entire surface of the neck they frequently occur together (Plate 12), although in this situation the sarcopt is more often found than the psoropt. Other situations, such as the root of the tail, the poll, and the flanks, are comparatively infrequently involved in the disease, but, when these locations are attacked, the sarcopt is invariably the causative parasite. As the investigations which have occupied my attention during the past

Mange Parasites on perineal region and upper part of thigh of buffalo.

Mange Parasites on neck of buffalo. Both sides of the neck were equally affected.

nine months relate to three distinct phases in connection with the parasite, I propose to describe the results of my observations of each phase under a separate heading or part :—

Part I. A method is described which was found most advantageous for observing the daily average number of eggs laid by numerous ovigerous females in their galleries until the time of their death, and for studying the life-cycle of the Acarus.

Part II. The important problem dealing with the resistance of the parasite to adverse natural and artificial conditions is here studied. For convenience, I have divided this part into two sections. The first section deals with the longevity of each stage of the parasite apart from its host and exposed to the variable influences to which it may be subjected in its natural habitat. The results of numerous experiments upon the effects of sunshine, darkness, moisture, and dryness, operating at room temperature, are recorded. In the second section, the relative power of resistance of the different stages to the action of an efficacious acaricidal agent, *viz.*, ten per cent. solution of creosote in olive oil, is considered.

Part III. This Part is devoted entirely to the consideration of the resistance of eggs to exactly the same passive and active conditions as those studied in *Part II.* It is also divided into two sections; the first refers to the length of time an egg may be separated from the host on which it was laid without losing its faculty of hatching; and the second section deals with the effect of exposures of varying duration to a solution of ten per cent. creosote in olive oil on its vitality.

PART I.

Observations upon the prolificness of an ovigerous female, and the life-cycle of the sarcoptic parasite of the buffalo.

In order to carry out these investigations I imitated the method employed by Shilston * for studying the life-cycle of the *Psoroptes communis* var. *ovis* in South Africa. For his work, Shilston used glass tubes three inches deep, two inches in diameter, and one eighth of an inch in thickness. After he had prepared on the back of a sheep, by shaving and cleaning, a circular patch of skin of the same diameter as the tube, he fixed one end of a tube to the integument by running melted paraffin wax around its base and tied tufts of wool over the upper end. The wax and the strands of wool prevented the dislodgment of the tubes.

* SHILSTON, A. W. Sheep Scab. Some observations on the life-history of *Psoroptes communis* var. *ovis* and some points connected with the epizootiology of the disease in South Africa. *Veterinary Research Laboratory, Allerton, Pietermaritzburg,* 1915.

For my experiments it was necessary to devise a means of fixing a circular glass cover to the back of a buffalo without supplementary aid. After testing the adhesive properties of a large number of substances, including paraffin wax, I had recourse to a special substance known commercially as "Chatterton's compound."* Instead of glass tubes of the kind Shilston used, I utilized a Petri dish cover with thicker walls. As the compound is obtainable in sticks, a small piece was chipped off with a knife and melted in an enamel basin: melting point 38°C. The fluid mixture was applied to the rim of the glass with a camel-hair brush. It may be added that, as the adhesive powers of this substance are small when it is dry and hard, it is essential that the glass circle should be placed on the animal immediately after the mixture has been applied to it. But, if the substance should have hardened, it may be melted again in a flame.

With experience, I learned that my experiments were vitiated when the rim of vertical glass wall was smeared over its entire thickness with the compound, as the substance becomes softened by the heat of the body, it extends into the circular area circumscribed by the glass ring. Wandering Acari were trapped in it, and as they were unable to extricate themselves from it, they died quickly. Accidents of this nature were eventually obviated by applying the substance to the outer edge of the rim only.

Petri dishes of small size were used, the diameter ranging from inch to one and a half inches. The dishes must be small for two reasons: firstly, because the compound will only keep the dish fixed to the skin when its rim is resting on a flat surface; and secondly, it is impossible to find a flat area of greater width than one and a half inches on the body of even the largest buffaloes. If a rim is applied to an uneven surface the lack of contact at the low lying parts of the skin causes the occurrence of gaps through which the Acari can escape. The roof of each dish was perforated with a large hole for ventilation. The hole was made by allowing hydrofluoric acid to act upon an area of the glass of the desired dimensions for three or four days. Lastly, the hole in the dish was covered with a single layer of muslin, dyed black, and fixed with seccotine. The object of using muslin to cover the opening was to limit to a minimum the ingress of dust which would otherwise have entered the circumscribed area in abundance, and thus have added considerably to the difficulty of recovering eggs. As the Acari seldom dis-

* The formula and method of preparation of Chatterton's compound are as follows:—Stockholm tar one part; resin one part; pure gutta-percha three parts (by weight). Prepare by melting the tar and the resin in steam-jacketed vessels, and, after filtering the gutta-percha, add in thin shreds and mechanically mix by horizontal stirrers revolving in a vertical shaft.

played a tendency to climb up the surface of the glass and make their escape, loss of parasites through the opening was not much feared ; but nevertheless, I deemed it expedient to dye the muslin black so as better to detect any that might have sought to escape. On a few occasions I have found Acari dead in the seccotine around the margin of the opening.

On account of the relative flatness of its surface, the portion of skin lying laterally between the vertebral column and the angle of the haunch was selected for my experiments. An ovigerous female that had been picked out of a scraping taken an hour or two previously was transferred to the flattest part of this area on the tip of a needle mounted in a wooden handle. A Petri dish unsmeared with the compound was placed over the area where the observation was intended to be made. The behaviour of the Acarus on finding itself in its natural habitat depended largely on the warmth of the day, and was especially influenced by sunshine. On a warm, sunshiny day, it became active immediately ; but on a day when no sunshine gleamed on the skin its movements were sluggish for many minutes. In the majority of my observations the parasite wandered over the skin attempting to insinuate itself beneath the rim of the glass, but rarely attempted to climb up the ring. After a duration varying from ten to thirty minutes, it became stationary, and, in about ninety per cent. of my observations, the resting place was the root of a hair. The parasite remained in a state of immobility for quite a long time, the only movement discernible through a hand-lens being a vigorous activity of the anterior legs in the act of beginning excavation operations. This movement impressed me by its similarity to the movements of a dog tearing a depression in a sandy soil. By slow degrees the visible portion of the Acarus became less and less manifest, until finally the long bristles of the posterior legs disappeared from view. Neumann * states that the length of time occupied by an ovigerous female in excavating a gallery is from fifteen to thirty minutes ; but I have repeatedly witnessed the female spending an hour and even longer, in tunnelling the initial portion of her gallery.

One female only was used for each observation. In quite a large number of cases it made no attempt to dig its way beneath the epidermis and was found dead the following day on the surface of the skin. As soon as the parasite was seen to disappear, the spot where the disappearance occurred was marked with a yellow grease pencil and the Petri dish fixed firmly above it. The next day the dish was removed and

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* NEUMANN. Parasites and Parasitic Diseases of domesticated animals. Fleming Translation. London, 1892.

search made for the mite. By means of a needle, it was easy to lay open the track and discover it. The number of eggs was counted, and either removed or transferred to a fresh part of the enclosed field. The female was taken up and placed on a slide on the warming-stage to ascertain whether it was still alive and whether its movements were active or sluggish. It was replaced on the spot from which it had been removed and the observation continued. The removal of the parasite each day did not seem to hinder its egg-laying activities. Thirty observations of excavating females were recorded. After one day death took place in three cases ; after two days in one ; after three days in two ; after four days in three ; after five days in six ; after six days in five ; after seven days in four ; after eight days in three ; after nine days in two ; after ten days in one. Ten days was the maximum duration of the life of an ovigerous female in experimental conditions. In most of the observations the female continued laying until the time of its death. Below is a table representing the aggregate number of eggs laid by the six females, three of which survived for eight days, two for nine days, and one for ten days.

TABLE 1.

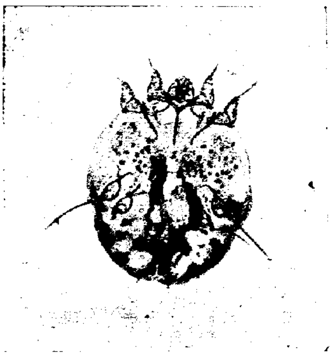
Aggregate number of eggs laid by six females during ten days.

No. of days.	No. of eggs recovered.	Average for each female.	REMARKS.
1	Thirteen . .	Two and a half . .	One female contributed no eggs.
2	Nine . .	One and a half . .	All laying.
3	Ten . .	Nearly two . . .	Do.
4	Five . .	Nearly one . . .	Only four contributed.
5	Twelve . .	Two	Each laid two eggs.
6	Twenty . .	More than three . .	All laying.
7	Twenty-one .	Three and a half . .	Do.
8	Fifteen . .	Two and a half . .	Do.
9	Six . .	Two	Only three laying.
10	One . .	One	Only one laying.

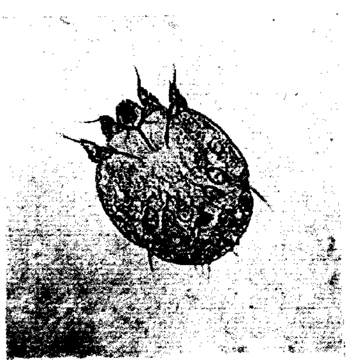
The total number of eggs laid during the first eight days, when all the mites were laying, was 105, *i.e.*, an average of seventeen to eighteen eggs for each female. This computation is not divergent from that made by Gerlach * whose calculations assigned fifteen eggs to each ovigerous female of *Sarcoptes scabiei* var. *hominis*.

* GERLACH, KRATZE AND RAUDE. Berlin, 1857.

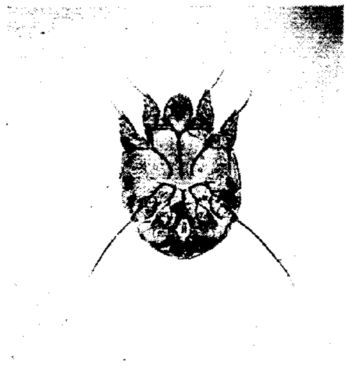
1. Ovigerous female, with egg.



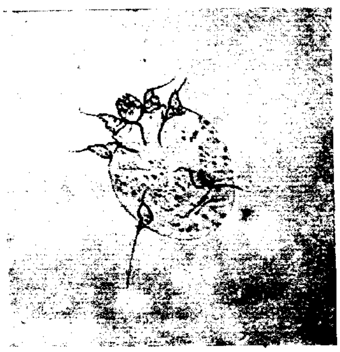
2. Pubescent female.



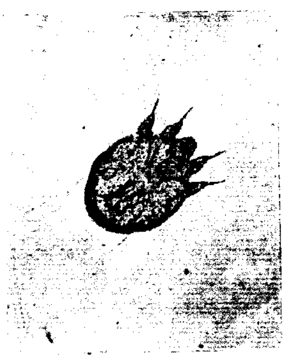
3. Nymph.



4. Male.



5. Large larva.



6. Small larva.

The various stages of the Sarcoptic Mange Parasite of the Buffalo.
(All figures magnified 41 diameters.)

Life-cycle of the buffalo Sarcopt.

Difficulties of an apparently insurmountable nature militated against achieving results of absolutely unquestionable significance regarding the life-cycle of this parasite. The hide of every buffalo is traversed by a net work of fine intersecting fissures, where the small forms of the larvæ and nymphs can effectually conceal themselves. In spite of every care it was found impossible to keep a male under observation for longer than half-an-hour on account of its dark-brown colour blending with that of the hide. Realizing that I could not hope to observe with indisputable accuracy the duration of each stage and the length of the quiescence synchronous with each moult, I determined to ascertain the number of days that elapsed between the hatching of the egg and the attainment of adolescence. A number of experiments was conducted with newly-laid eggs. It was easy to ascertain the interval between laying and hatching. In ninety per cent. of my observations the interval was two days. In very few cases three days were required for the development of the larvæ, and in a fairly large number of trials the interval was about one and a half days. A number of newly-laid eggs was put under cover, and two days allowed for them to hatch. At the end of three, four, five, six, seven and eight days, the covers were removed and a search made for the young forms. On the day following upon the hatching of the eggs, *i.e.*, on the first day, one or two larvæ were occasionally seen. Usually they were careering across the area, and more rarely were lying motionless in a fissure or under a crust. When removed to the warming-stage they were extremely active. Sometimes a dead larva was recovered on this day. On the second day the few larvæ seen were distinctly larger than those seen on the previous day. They also were agile. On the third day, in a few of the numerous experiments I conducted, a small nymph was found. Larvæ could also be found in the fissures. On the fourth day no larvæ were ever met with ; one or two nymphs of different sizes were occasionally picked up. On the fifth and sixth day the task of recovering the parasites was considerably easier than on any previous day, owing to the larger dimensions of the parasite, and the glistening whiteness of its body. The sixth day sometimes revealed nymphs of large magnitude, which might be considered pubescents. On the seventh day, only an isolated nymph of small size could be recognised ; the majority of the parasites had reached the state of puberty. By the eighth day no nymph was ever recognised ; all the mites had reached adolescence. When kept under cover no pubescent female survived longer than four days. Attempts to bring about the fertilization of the pubescents failed. On numerous occasions males and pubescents were

placed together, but no evidence of copulation having taken place was ever discernible. These observations would therefore assign six to eight days as the interval between hatching and adolescence.

It may be appropriately mentioned here that the Sarcopt of the buffalo is considerably smaller than its equine counterpart. In the table below the comparative dimensions of the egg and the various stages of the two species are recorded. The measurements of the Sarcopt of the horse are from Mégnin, quoted by Noel Pillers.*

TABLE II.

Comparison between the dimensions of the Sarcopt of the horse and of the buffalo.

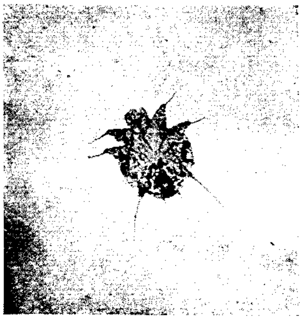
—	SARCOPT OF HORSE.		SARCOPT OF BUFFALOES.	
	Length in m.m.	Breadth in m.m.	Length in m.m.	Breadth in m.m.
Egg	·16	·10	·12—·19	·10—·12
Larva	·16—·25	·10—·17	·15—·18	·10—·15
Nymph	·30	·20	·19—·23	·15—·19
Male	·26—·28	·18—·20	·19—·28	·16—·21
Pubescent	·35—·40	·25—·30	·27—·37	·19—·30
Ovigerous Female	·45—·47	·35	·36—·39	·28—·31

PART II.

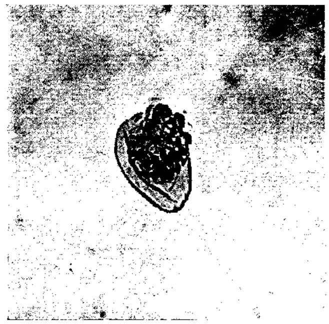
SECTION I. *The duration of vitality of the different stages of the Acarus apart from the body of their host, under varying conditions, in regard to temperature, light and moisture.*

For each experiment one ovigerous female, one pubescent female, two males, one nymph, and two larvæ were used. The mites were picked up with a needle mounted in a wooden handle, from a scraping in a Petri dish resting on the warming stage. At the beginning of the experiments different forms were recognized through the low-power objective of the microscope; but with the acquisition of a little experience, I was able to identify the stage of the parasite through a hand-lens magnifying ten times. The group of parasites was placed on an ordinary glass slide in the middle of a circle made with a yellow grease pencil. I assured myself that none of them had been injured in the course of being picked up by warming the slide before submitting the group to the longevity

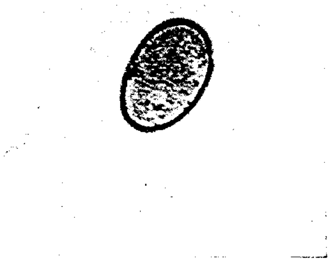
* PILLERS, A. W. NOEL. "Notes on mange and allied mites." 1921.



7. Newly-hatched larva.

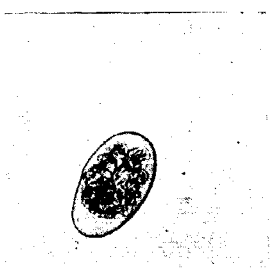


10. Larva emerging from egg.



8. Newly-laid egg.

11. Degenerated appearance of egg kept for five days at room temperature.



9. Larva inside egg-case.

12. Degenerated appearance of egg exposed for twenty minutes to ten per cent. creosote in olive oil.

Sarcoptic Mange Parasite of the Buffalo. (All figures are magnified 49 diameters.)

test. Four groups were assembled; the first was placed on the bench of the laboratory in a place exposed to sunshine for two or three hours each day. The temperature in the sunlit part of the bench ranged from 16°C to 20°C; at other times of the day it varied from 10°C to 12°C. The second group was placed on the top of an incubator regulated at 31°C. The temperature of this situation was never lower than 13°C nor higher than 15°C. The sunbeams never reached the part of the room where the incubator stood. The third group was placed in a cupboard kept in total darkness, but effectually ventilated. The temperature of the cupboard ranged from 8°C to 10°C. The last group was placed in a situation inaccessible to the rays of the sun, and moistened with pieces of cotton-wool and cloth soaked in water. The temperature usually ranged from 7°C to 10°C.

At intervals of twenty-four hours each group was warmed on the stage, and replaced in its situation until all the members were dead. At least forty tests under the four conditions enumerated were carried out. The variations in the results of the tests of each group were remarkably slight. A typical result in each of the four groups is detailed below.

GROUP I.

(PLACED ON BENCH AND WARMED FOR TWO TO THREE HOURS DAILY BY THE SUN'S RAYS.)

After one day . . .	All actively alive.
,, two days . .	One male sluggish; others active.
,, three days . .	One male motionless; the other male sluggish; both larvæ sluggish; nymph's vitality weakened; ovigerous and pubescent active.
,, four days . .	Both males and both larvæ motionless; nymph feeble; ovigerous and pubescent moving fairly actively.
,, five days . .	Nymph motionless; pubescent sluggish; ovigerous slightly weakened.
,, six days . . .	Movements of pubescent very faint; ovigerous sluggish.
,, seven days . .	All motionless.

GROUP II.

(PLACED ON TOP OF INCUBATOR; INACCESSIBLE TO THE SUN.)

After one day . . .	All actively alive.
,, two days . .	Both males and one larva feeble; others still active.
,, three days . .	Both males and both larvæ motionless. Nymph sluggish. Ovigerous and pubescent fairly active.
,, four days . .	All except ovigerous and pubescent motionless. Pubescent faintly alive. Vitality of ovigerous weakened.
,, five days . .	All motionless.

GROUP III.

(PLACED IN DARKNESS.)

After one day . . .	One male motionless. Both larvæ and the other male sluggish. Others active.
,, two days . .	One larva motionless. The remaining larva and male dying; nymph only feebly alive; pubescent and ovigerous sluggish.
,, three days . .	Both males and larvæ apparently dead. Nymph dying. Ovigerous and pubescent move with difficulty.
,, four days . .	All motionless.

GROUP IV.

(PLACED IN MOIST, DIMLY-LIGHTED SITUATION.)

After one day . . .	One male and one larva motionless; the other male sluggish, all others active.
,, two days . .	Both males and one larva motionless; the other larva dying; nymph sluggish; ovigerous and pubescent fairly active,
,, three days . .	All except ovigerous and pubescent apparently dead. Both of the latter in a feeble state.
,, four days . .	All motionless.

The results of the above experiments demonstrate with convincing clearness that the vitality of the male and the larva is about equal, and that the vitality of these two stages is much less than that of the other stages. In no instance did a male give evidence of possessing a greater vitality than that of an ovigerous female, and a larva lived as long as the latter on one or two occasions only. In all the experiments, a larva of large and small size were used. The former was invariably more resistant to the adverse conditions imposed upon it than was the latter. The vitality of the ovigerous female is just appreciably greater than that of the pubescent female. In quite a large proportion of the tests the pubescent survived the other, but the aggregate result of the experiments proves that the ovigerous female possesses greater powers of resistance. The position of the nymph in this respect is intermediate between that occupied by the male and the pubescent female. Not infrequently it lived as long as any other member of its group, but, in general, its resistance might be assigned a place inferior to that of the adults.

The effect of protracted exposure to cold on the vitality of the Acari is noteworthy. For a period of ten days or so at the beginning of last December, a wave of intense cold passed over Muktesar. On entering my laboratory in the morning, I observed the temperature of my working-bench to be 4°C or 5°C. The temperature did not rise above 7°C during the whole day except in places near the fire.

The group on the slide were dealt with in a manner precisely like that employed with Group I. The effect of sunlight was more than neutralized by the severity, and especially by the protracted duration of the exposure to cold. After two days both males and both larvæ were usually dead. The vitality of the others was noticeably reduced, and, in some observations, the nymph was in a dying state. On the following day the ovigerous and pubescent females alone retained indications of feeble vitality. After four days all were dead. About ten experiments were made during this cold weather, and only in one instance did an ovigerous female survive four days' exposure.

It is reasonable to assume that parasites left among the epidermal debris would survive for a longer period than those removed from it. Gerlach estimated the duration of the human Sarcopt when put in a watch-glass and exposed to ordinary summer temperature at five to six days; and the duration among scrapings at eight to ten days. The crusts had the property of prolonging life two-fold. My experiences differ entirely from those quoted. It was rare to note evidences of life in a scraping after the group of parasites which had been removed from it had died. On the contrary, I have frequently failed to notice in such circumstances a single living form in a scraping while the females on the slide were still distinctly alive.

PART II.

SECTION 2. *Relative degrees of resistance of the different stages to a solution of ten per cent. creosote in olive oil warmed to 31°C.*

The second series of tests was performed with a mixture of ten per cent. creosote in olive oil. Pure creosote was specially obtained for these tests on account of the unsuitability of the crude creosote already in stock. A member of each stage of the parasite was submitted to the action of this drug maintained in the incubator to 31°C, for varying periods of exposure.

The procedure employed was as follows. The scraping was taken in a paper envelope from a badly infected buffalo at the animal hospital, which is about a mile from the laboratory. On receiving the envelope, I divided its contents into two portions, which were put into separate Petri dishes. One dish was placed in the incubator at 31°C to be thoroughly warmed for half-an-hour before use, and the other was left on the bench. The temperature of the room was usually 12°C to 15°C.

The warming-stage was heated by means of a spirit lamp, and when the temperature of its surface reached 30°C to 32°C, the spirit lamp was

manipulated in such a manner as to ensure the maintenance of this degree of heat uniformly for several hours. Workers unaccustomed to the use of a warming-stage may be led into serious errors through lack of knowledge concerning the method of obtaining a uniform temperature throughout the platform. The thermometer incorporated with the stage registers a rise in temperature very slowly : when the mercury reaches the mark 30, it will be found that the temperature of the surface has ascended to 45° or higher. By keeping the bulb of a thermometer on the surface of the stage, I have observed that this part of the apparatus reaches 30°C, before the integrant thermometer records 20°C. With continued heating the difference between the actual and registered temperatures gradually decreases, until after half-an-hour it is less than two degrees. Ignorance of this important point was the cause of the vitiation of many of my earlier experiments. After the surface had remained uniformly at 30°C for a few minutes, the scraping was removed. from the incubator and placed upon the stage. Meanwhile a number of slides containing each a large drop of the reagent was put into the incubator to be warmed to the required temperature. As soon as an ovigerous female, a pubescent female, a nymph, a male, and two larvæ (one large and one small) had been isolated from the scraping, a slide was taken from the incubator and put on the warming-stage. In order to make certain that all the Acari possessed complete vitality, the slide on which they lay was also placed on the stage at the side of the other. Almost immediately they began to run swiftly along the glass surface. They were then picked up one by one by means of a needle and placed in the drug. Any parasites that appeared to be injured were not used. The greatest activity was usually exhibited by the males and larvæ, which sometimes ran with great speed. The ovigerous female was always more sluggish than a member of any other stage. As the relatively greater resistance of the ovigerous and pubescent females to the action of the drug had been demonstrated beforehand in very numerous experiments, these stages were always placed in the drug first. The entire length of time occupied in transferring the six Acari never exceeded thirty seconds. The reason why they were placed in the same drop was that all of them could thus be observed at the same time with the low power lens. The duration of exposure ranged from three minutes to thirty minutes. At the expiration of the period of exposure, the parasites were rapidly washed with a reagent capable of removing oil quickly. After experimenting with a number of reagents, including xylol, ether, one per cent. acid alcohol, a weak solution of sodium hydroxide and warm water, I selected ether as the most rapid cleansing agent. A few drops of it were placed around the large drop of oil and allowed

to mix with it thoroughly. By tilting the slide the oil was run down its surface and wiped off with a piece of muslin cloth. A second application of ether was generally sufficient to wash completely away all traces of the oil. During this operation great care had always to be taken to avoid losing the mites. As the ether had now replaced the oil, and formed small pools about the bodies of the Acari, it was considered desirable to remove them to a part of the slide untouched with either oil or ether. The removal was effected by means of a special brush, because the slippery nature of their bodies resulting from contact with oil rendered them liable to be damaged in attempts to pick them up with a needle. The whole operation of washing and removing to a dry part of the slide usually occupied one minute. The slide was then replaced on the warming-stage to see whether any of the Acari revealed signs of reviving life or not. Only on rare occasions was evidence of resuscitation observed so soon after washing. The slide was next replaced in the incubator for one or two hours in order to accustom surviving parasites to favourable thermal conditions. At the end of this interval the slide was again placed on the warming-stage, and after inspection it was put on the laboratory bench. At various times during the ensuing three or four days it was warmed to ascertain whether the mites had revived from the effects of the drug, and, if they revived, how long life would still linger in them.

A few typical results of tests applied over a period of more than six months are given below.

Experiment 1.

1 ovigerous, 1 pubescent, 1 male, 1 nymph, 2 larvæ (large and small) exposure	3 minutes.
All struggled violently as soon as they found themselves in a harmful medium.	
Male and small larva become quiescent after . .	1½ minutes.
Nymph and large larva ,, ,, ,, . . .	2 ,,
Ovigerous and pubescent ,, ,, ,, . . .	2½ ,,
After washing . All motionless.	
1 hour later . All revive.	
4 ,, ,, . ,, ,,	
24 ,, ,, . Ovigerous, pubescent, nymph, male, and large larva alive.	
48 ,, ,, . Ovigerous and pubescent alive.	
72 ,, ,, . ,, ,, ,,	
96 ,, ,, . ,, ,, ,,	
120 ,, ,, . ,, alive.	
144 ,, ,, . All dead.	

In many experiments I used two males in order to provide against a possible accident to one.

Experiment 2.

1 ovigerous, 1 pubescent, 1 nymph, 2 males, 2 larvæ (large and small)	5 minutes.
Both *males* and *small larva* assume quiescence after . .	1 minute.
Large *larva* assumes quiescence after	1½ minutes.
Nymph and *pubescent* assume quiescence after	2 ,,
Ovigerous exhibits feeble movements up to	3 ,,

After washing . .	All motionless.
1 hour later . .	Ovigerous and one male revive.
3 hours later . .	All revive.
24 ,, ,, . .	Ovigerous, pubescent, nymph, one male, and large larva alive.
48 ,, ,, . .	Ovigerous and pubescent alive.
72 ,, ,, . .	,, ,, ,,
96 ,, ,, . .	,, alive.
124 ,, ,, . .	All dead.

Experiment 3.

1 ovigerous, 1 pubescent, 1 nymph, 2 males, 2 larvæ (large and small)	10 minutes.
One *male* and *small larva* cease struggling after . .	1 minute.
The other *male, nymph* and *large larva* cease struggling after	2 minutes.
Pubescent ceases struggling after	2½ ,,
Ovigerous ceases struggling after	3 ,,

After washing . .	All motionless.
1 hour later . .	,, ,,
3 hours later . .	All revive (one male feebly).
24 ,, ,, . .	All alive except one male.
48 ,, ,, . .	Ovigerous, pubescent and large larva alive.
72 ,, ,, . .	All motionless.

Experiment 4.

1 ovigerous, 1 pubescent, 1 nymph, 2 males, 2 larvæ (large and small)	15 minutes.
Both males and *both larvæ* become quiescent after . .	1½ ,,
Nymph and *ovigerous* become quiescent after . . .	2 ,,
Pubescent become quiescent after	2½ ,,

After washing . .	All motionless.
3 hours later . .	All revive except one male.
24 ,, ,, . .	Ovigerous, pubescent and large larva alive.
48 ,, ,, . .	Ovigerous and pubescent alive.
72 ,, ,, . .	All motionless.

Experiment 5.

1 ovigerous, 1 pubescent, 1 nymph, 2 males, 2 larvæ (large and small)	15 minutes.
All except *ovigerous* and *pubescent* become quiescent after .	1½ ,,
Pubescent becomes quiescent after	2 ,,
Ovigerous becomes quiescent after	2½ ,,

After washing . .	All motionless.
2 hours later . .	„ „
3 „ „ . .	Pubescent revives faintly.
4 „ „ . .	Ovigerous, pubescent, nymph and large larva alive.
24 „ „ . .	Pubescent and nymph alive.
48 „ „ . .	„ alive.
72 „ „ . .	„ alive.
96 „ „ . .	All motionless.

Experiment 6.

1 ovigerous, 1 pubescent, 1 nymph, 2 males, 2 larvæ (large and small)	20 minutes.
One *male* becomes quiescent after	1 minute.
The other *male, nymph* and *both larvæ* become quiescent after	1½ minutes.
Pubescent becomes quiescent after	2 „
Ovigerous becomes quiescent after	2½ „

After washing . .	All motionless
1 hour later . .	„ „
3 hours „ . .	„ „
24 „ „ . .	„ „

Experiment 7.

1 ovigerous, 1 pubescent, 1 nymph, 2 males, 2 larvæ (large and small)	20 minutes.
Both males, nymph and *small larva* become quiescent after	1½ „
Large larva and *pubescent* become quiescent after . .	2 „
Ovigerous becomes quiescent after	2½ „

After washing .	All motionless.
1 hour later .	„ „
3 hours „ .	Ovigerous and pubescent revive feebly.
6 „ „ .	„ feebly alive.
24 „ „ .	All dead.

Experiment 8.

1 ovigerous, 1 pubescent, 1 nymph, 2 males, 2 larvæ . .	30 minutes.
All except *ovigerous* and *pubescent* cease moving after .	1½ „
Ovigerous and *pubescent* cease moving after . . .	2½ „

After washing .	All motionless.
1 hour later .	„ „
3 hours „ .	„ „
4 „ „ .	„ „
24 „ „ .	„ „

Experiment 9.

1 ovigerous, 1 pubescent, 1 nymph, 2 males, 2 larvæ . .	30 minutes.
Both *males* and *small larva* become quiescent after . .	1 minute.

Large larva, nymph and *pubescent* become quiescent after	.	2 minutes.
Ovigerous becomes quiescent after	.	$2\frac{1}{2}$,,
After washing	.	All motionless.
1 hour later	.	,, ,,
3 hours ,,	.	,, ,,
6 ,, ,,	.	,, ,,
24 ,, ,,	.	,, ,,

The examples given above form an epitome of several hundreds of tests carried out during a period of six or seven months. Examination of the results reveals the existence of a great difference in the degree of resistance to the effect of the drug among the various stages of the buffalo Sarcopt. In all the examples quoted, and in about ninety-five per cent. of the total tests, the ovigerous and the pubescent females displayed the greatest degree of resistivity; the male and the small larvæ occupy, as it were, the opposite pole in this respect, and the nymph and large larvæ lie in an intermediate position. All forms usually revived within twenty-four hours after exposure for ten minutes. After fifteen minutes exposure it was not unusual for all to revive, but the male and the larvæ were so exhausted from their contact with the drug that they did not retain their vitality long.

It is evident from the experiments of Henry * that the Sarcopt of the buffalo has a greater degree of resistance to this drug than the Psoropt of the horse. This author fixes fifteen minutes as the maximum length of exposure requisite to prevent resuscitation. Another feature of importance respecting the results of his investigations and mine is that he considered the larvæ slightly more resistant than the other stages, whereas in my inquiries its vitality was invariably inferior to that of the adults and nymph. In a few cases the male and the large larvae survived for twenty-four hours after the test, but the vast majority of them succumbed within a few hours after washing. One or two isolated examples of the survival of the small larvae are recorded in my note-book.

When exposed for twenty minutes, all forms died in about seventy per cent. of the tests; in the remaining thirty per cent. the ovigerous female, and less frequently the pubescent, revived. The revival was so feeble, however, that no evidence of life was ever seen in them after twenty-four hours. An exposure of thirty minutes effectually kills all stages. When tests were carried out with drops of the drug previously warmed to 31°C, and kept constantly at that temperature on the warming-stage for half-an-hour, no instance of revival was encountered. Many of my earlier experiments demonstrated the capability of the older forms of the parasites to resist exposure for thirty minutes, but in the light of

* HENRY, A. Sur le pouvoir acaricide de quelques substances utilisées dans la gale des équidés. *Rec. med. vet.*, Sept. 1921, Vol. 94, No. 18, pages 357—382.

knowledge gained from further experience, I ascribe these results to faulty technique.

A feature of importance regarding the appearance of the parasite in the oily medium, and its revival from the action of the reagent, may be recorded here. As soon as the parasite was placed in the warm creosoted oil, a peculiar rotatory movement of abdominal elements began. This motion persisted long after the struggles of the Acarus had subsided. I observed that in nearly all cases in which this agitation continued up to the end of the test, resuscitation took place ; but, on the other hand, revival of mites in whose bodies the movement had ceased, occurred with great frequency. The rotating elements lie about the middle of the body, and maintain a rhythmical oscillation, which varies considerably in its rate of movement. After three minutes in the drug, the motion usually reaches the point of most marked acceleration, and tends to become slower as the exposure is prolonged. This feature was observed in large number of all the stages except the male. On re-warming the slide after removing the Acari from the agent, the earliest sign of latent life was frequently evinced by the commencement of this agitation. If it developed in speed and in volume, early revival of the mite invariably occurred. If it continued to rotate slowly and inertly, feeble resuscitation or continued inactivity usually followed. In the case of the male, signs of life were frequently displayed by the passing of bubbles of oil up and down the œsophagus, before visible movements of the legs and jaws became discernible.

PART III.

SECTION 1. *The viability of the eggs of the buffalo Sarcopt under adverse conditions.*

The viability of the eggs was investigated in the conditions wherein the relative powers of resistance of the different stages of the Acarus were determined. First of all, I satisfied myself with regard to the period of incubation. Eggs which had been laid since inspection of females taken from the body on the previous day were removed to a fresh portion of the body, and covered with a Petri dish. All these eggs hatched within forty-eight hours after transference to the fresh patch. The same constancy in hatching was not displayed by eggs obtained from a scraping. About twenty per cent. of the latter were sterile.

The rapidity of hatching would seem to depend upon variations of atmospheric temperature. In summer few eggs remained unhatched at the end of twenty-four hours ; but in winter hatching usually occurred on the second day. Eggs collected from a scraping taken on the morning of the day on which they were used, revealed no difference in respect

to the incubative period. As the eggs collected from the experimental buffalo had been laid not longer than twenty hours, the period of incubation would, therefore, range from two to three days.

It is interesting to compare this calculation with those made by various observers whose computations are quoted by Neuman. The eggs of the equine Sarcopt were the subject of their investigations. Gerlach calculated the incubative period at three days ; Fürstenberg at six to seven days ; Bourguigon and Eichstadt at ten days ; Burchart at five days ; Megnin at one to two days. Some of these observations were made in an incubator heated to the temperature of the body. When a collection of eggs was placed in an incubator, I noted that either they hatched within three days or they degenerated. I have never observed an egg, which did not hatch in three days in the incubator, retain its power to hatch when transferred to the body of the host.

A long series of experiments was made with the object of acquiring definite knowledge regarding the maximum length of time the eggs can retain their faculty of hatching when kept in a watch-glass at room temperature (10°C—13°C). Most of the eggs used for these experiments were obtained from scrapings ; but a small proportion of them were recovered from the experimental area on the buffalo. The eggs were divided into batches of ten, and laid on the bench for a certain length of time. The duration of the tests ranged from one to ten days. Two batches were submitted to the same period of insulation, and then incubated, one on the body of the animal, and the other in the incubator. The following table indicates the results of these tests.

TABLE III

Illustrating the number of days eggs of the buffalo Sarcopt, per batches of ten, can retain their power for hatching apart from the host, and the relative incubative value of the hosts body and a thermostator regulated at 25°C—27°C.

No. of days.	Incubated on body.	Incubated in thermostator.
One	Nine	Seven.
Two	Eight	Four.
Three	Six	Three.
Four	Five	One.
Five	Two	None.
Six	One	,,
Seven	None	,,
Eight	,,	,,
Nine	,,	,,
Ten	,,	,,

Each of these experiments was repeated three times in some cases and four times in others. In no instance did an egg which had been separated from the host for five days hatch in the incubator; and no egg separated for seven days hatched on the body of the animal. Shilston and Stockman (*ibid*) ascertained that a separation of eight days was the maximum an egg of the sheep scab Psoropt could withstand and retain its faculty of hatching. The former author replaced the eggs on the back of a sheep, and the latter used an incubator. Gerlach (*ibid*) records the interesting case of an egg of the equine Sarcopt retaining its germinative faculty after keeping it apart from its host for four weeks.

Figure 11, Plate 14, illustrates a typical appearance presented by an egg which has failed to hatch in the incubator on the completion of five days retention, and figure 12, Plate 14, the appearance of an egg that has been in contact with ten per cent. creosote in olive oil for twenty minutes and subsequently incubated.

SECTION II.

The effect of exposures of varying durations to a solution of ten per cent. creosote in olive oil on the germinative faculty of the egg.

Parallel experiments were made in precisely the same manner as described in detail in Section I of this part. The durations of exposure to the drug were the same as the Acari underwent. A batch of ten eggs was used for each experiment. In the Table below the results of these observations are recorded.

TABLE IV

Illustrating the effect of exposure to a solution of ten per cent. creosote in olive oil for varying periods on the buffalo Sarcopt egg and the relative incubative value of the host's body and a thermostator.

No. of experiment.	Duration of exposure.	Incubated on body.	Incubated in thermostator regulated at 25°C—27°C.
1	Three minutes	Eight hatched; five in two days and three in three days.	Five hatched; four in two days and one in three days.
2	Five minutes .	Six hatched; two in two days, three in three days, and one in four days.	Three hatched; all in three days.

No. of experiment.	Duration of exposure.	Incubated on body.	Incubated in thermostator regulated at 25°C—27°C.
3	Five minutes .	Five hatched; one in two days and four in three days.	Three hatched; all in three days.
4	Ten minutes .	Two hatched in three days.	One hatched in two days, and one in three days.
5	Ten minutes .	One hatched in three days.	Two hatched; one in one and a half days, one in three days.
6	Fifteen minutes	One hatched in three days.	One hatched in three days.
7	Fifteen minutes	Two hatched in three days.	One hatched in three days.
8	Twenty minutes	None hatched . .	None hatched.
9	Twenty minutes	One hatched in three days	One hatched in three days.
10	Thirty minutes	None hatched . .	None hatched.
11	Thirty minutes	None hatched . .	None hatched.

The experiments pertaining to the shorter exposures were repeated three times: all others four times. Except on a few occasions, an exposure of twenty minutes in the drug kept at the constant temperature of 31°C was sufficient to prevent hatching. Though the number of larvæ that issued or attempted to issue from the egg-case was small, a large number, moreover, was seen to struggle vigorously inside the egg without being able to break through the egg wall. Figure 10, Plate 14, illustrates a larva in the act of emerging from the egg-case. The egg had been subjected to an exposure of ten minutes, and placed in the incubator. It was never observed that an egg which had undergone an exposure of thirty minutes in the drug revealed evidence of progressive development.

Investigations conducted by Stockman and Berry * regarding the effect of a creosoted dip (the composition of the dip and the proportion of creosote are not stated) on the vitality of the egg of *Psoroptes communis* var. *ovis* afford an interesting contrast to the results recorded

* STOCKMAN, S. AND BERRY, A. H. *The Psoroptes communis ovis*: some observations *on Ova and ovipositing*. Jour. Com. Path. and Ther., 1913. Vol. XXVI, pages 45—50.

above. They made three observations with the dip on a large number of eggs. In the first observation 100 eggs were placed in the medium for one minute and incubated at 25°C—27°C : none hatched. In the second, eighty eggs remained in contact with the acaricide for half-a-minute : none hatched. 300 eggs were used for the third experiment, and after an exposure of half a minute only one egg developed a larva.

Summary.

The average number of eggs laid by an ovigerous female under experimental conditions was seventeen to eighteen.

Ten days was the maximum duration of life of an egg-laying female.

The interval between hatching and the attainment of adolescence was six to eight days.

The ovigerous and pubescent females can withstand a longer separation from their host than can the other stages. The power of resistance to insulation is weakest in the male and small larvæ. The nymph and large larvæ occupy an intermediate position.

The influence of sunshine in prolonging and the action of cold in curtailing the resisting powers of the Acari were convincingly demonstrated.

An exposure of twenty minutes to the action of a solution of ten per cent. creosote in olive oil, warmed to 31°C, killed all males, nymphs, larvæ, and the majority of ovigerous and pubescent females. Tested by this acaricidal agent, the powers of resistance of the different stages corroborate the finding in regard to their resistance to more insulation.

The incubative period is one to two days at summer temperature, and two to three days in winter.

No egg separated for five days from the host hatched in the incubator (25°C—27°C) ; and after seven days at room temperature (10°C—13°C) no egg hatched when subsequently placed in the host's body.

Contact with eleven per cent. creosote in olive oil for thirty minutes kills all eggs. Only a few survive an exposure of twenty minutes.

I should like to ask Mr. Timoney, if eggs are killed by the application of creosote, whether in practical application contact can be made between creosote and eggs laid in the galleries on the host ?

In practice it was rather difficult ; in the laboratory I actually put the egg in oil, as it was necessary to know the effect of the acaricide upon all the stages of the mite.

Mr. Timoney's paper represents only the commencement of the study of the important parasites causing mange. The disease is widespread

but very little work has been done on the subject; and most of the important observations on the bionomics of these parasites date back to the early half of last century. Some modern work has been done in South Africa and Europe. No improvement however in methods of control has been made since the time of the Greeks. During the late war many methods of treatment were tried but no exact knowledge of the life cycle was obtained. Henry in 1920 estimated the effect of drugs on mange parasites and found that most of the household remedies were ineffective. Thorough knowledge of the life-cycle may show up weak points at which the parasites may be attacked. Work will be continued until a satisfactory method of treatment has been discovered. Mr. Timoney's paper represents a considerable step forward in the knowledge of the life-history of the mange parasite.

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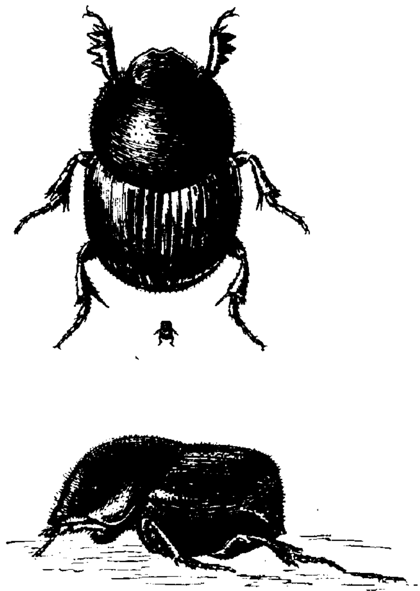

Caccobius mutans, **Sharp.**
(The small figure shows the natural size.)

29.—OCCURRENCE OF A COPRID BEETLE, *CACCOBIUS MUTANS*, SHARP, IN THE HUMAN INTESTINES.

By M. O. T. IYENGAR, B.A., F.Z.S., *Entomologist, Department of Public Health, Bengal.*

(Plate 15.)

Since the record of the occurrence of *Onthophagus bifasciatus*, Fb., (Coprinae, Scarabeidae) in the human intestine by Senior-White (1920) and by Senior-White and Sen (1921), very little information has been published. The records of the disease have been concerned mainly with the pathological condition of the disease. No records of the bionomics of the species responsible for the internal scarabiasis are available. The disease appears to be very common in various parts of India. Senior-White (1920) says that it is common in Ceylon. It also appears to be very common in Bengal. The records of Dey (1919 & 1920) from Faridpur, Sen (1919) from Khulna, and Chakravarti (1919) from Backerganj (Barisal) point to the disease being very common in Bengal. Unfortunately, except in a single case, the specimens were not determined specifically. Senior-White and Sen (1921) determined some of the insects as *Onthophagus bifasciatus*, Fb., and an undetermined species of the same genus.

Some specimens collected from the evacuations of a girl in the vicinity of Calcutta by Capt. Dey are apparently *O. bifasciatus*.

It now appears that besides this genus, another genus, *Caccobius*, closely allied to the above, also has similar habits, namely, of causing intestinal scarabiasis in man. Specimens collected by Dr. S. K. Sil at Damodya, Faridpur district, last year, were passed by a girl five years old. These have been determined as *Caccobius mutans*, Sharp, after comparison with the British Museum specimens, by Arrow. The species appears to be a very rare one.

Very little is known of the bionomics and life-history of this species and so it would not be safe to guess at the method of invasion of the intestines by these insects.

I am indebted to Mr. Arrow of the British Museum for so kindly determining the specimens submitted to him and to Mr. T. Bainbrigge Fletcher for his kindness in getting the insect figured.

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1. Senior-White, R. A. . 1920. On the occurrence of Coleoptera in the human intestines. (*Ind. Jl. Med. Res.*, Vol. VII, pp. 568-569.)

2. SENIOR-WHITE, R. A., AND SEN, S. K. 1921. Further notes on the occurrence of Coleoptera in the human intestines. (*Report Proc. 4th Ento. Meeting, Pusa*, pp. 236-239.)

3. DEY, A. C. 1919 . "Worms" (*Ind. Med. Gazette, Calcutta*, Vol. LIV, p. 318.)

4. DEY, A. C. 1920 . "Flying Worms." (*Ind. Med. Gaz., Calcutta*, Vol. LV, pp. 157-158.)

5. SEN, S. C. 1919. . "Flying intestinal worms." (*Ind. Med. Gaz., Calcutta*, Vol. LIV, p. 396.)

6. CHAKRAVARTI, S. K. . 1919 Flying insects from the rectum. (*Ind. Med. Gaz., Calcutta*, Vol. LIV, pp. 478-479.)

A similar case was discussed at the last meeting, and the authenticity of the observation has since been questioned in an issue of the Proceedings of the Entomological Society of London.

There appears to be no doubt in this case, as the beetles have been passed on several occasions by the same person.

It is necessary to scrutinise any such cases very carefully. I have myself met with cases where insects have been deliberately introduced into the stools by malingerers. One man was actually detected bringing in larvae of *Chrysomyia* wrapped in a fold of his "dhoti" and dropping them into the utensil while at stool.

In this case the patient was a girl five years old, and she exhibited symptoms of colic, while in other cases patients have had colic, diarrhœa, and have sometimes passed blood.

Was this case an indoor patient?

No. An outstation Doctor has been watching the case and forwarding specimens of the beetles ejected to me. One or two beetles at a time were ejected, and these at particular times of the year.

Was a rectal enema given the patient to see whether beetles actually came out of the intestines?

No, but in the case from Ceylon reported in the Proceedings of the Fourth Entomological Meeting a rectal enema was given.

What is the normal habit of the insect?

This appears to be a very rare form, and nothing is known about its habits.

Very little is known at present about the insect fauna of animal excrement, and especially of human excrement, in India, and work on this subject is very much required.

30.—THE IMPORTANCE OF ANIMAL PROPHYLAXIS IN MALARIA.

By M. O. T. IYENGAR, B.A., F.Z.S., *Entomologist, Department of Public Health, Bengal.*

Such a great deal has been written on the importance of cattle in the prevention of malaria, both in the medical press and elsewhere, that it may not be out of place to place before this Meeting of the Entomologists of India, a short *resumé* of the most important observations in regard to this subject, in order to consider how far the theory is applicable to India.

It has always been much easier for medical men and malariologists to collect mosquitos from cattle-sheds than from human dwellings. A great deal of patient search is necessary to collect Anophelines from inside a house, while a few minutes' search would easily yield a score of them in a stable or a cattle-shed. This has evidently been the main basis of most of the opinions expressed by workers, as will be seen from the following *resumé* of the literature.

Roubaud deserves the credit of having started this theory of animal prophylaxis when in 1919 he observed that in France man is greatly protected from malaria by the presence of his domestic animals. He observed that man is attacked by *Anopheles maculipennis* only in the absence of other mammalian blood. The preference of this mosquito to mammals, he observed, was in the following order : pigs, cattle, horses, goats, sheep, rabbits and dogs. Legendre supported Roubaud's views. In a subsequent paper, Roubaud observed that the attraction of *Anopheles maculipennis* to animals is directly in proportion to the size of the host. It has been said that Anophelines in England have never been known to bite man and the same may, he said, be true of the mosquitos in the heavily infested parts of France. He considered that man plays an unimportant part in the nutrition of this mosquito ; cattle, horses and mules being the favourable hosts. He concludes that man could have complete protection from the attacks of this species by keeping cattle in close proximity to human dwellings. He ventured the opinion that, where people complain of mosquitos, it is invariably the case that their stables contain but few animals. As a result of this, in regions where cattle are plentiful, a race of these mosquitos has evolved which have adapted themselves to their new hosts, with different taste,

affinities and also a larger size. Roubaud thought that these mosquitos bite man with repugnance when compelled to do so.

Wesenberg-Lond in 1921 observed that *A. maculipennis* had changed its feeding habits during the last century and, instead of attacking man, has now taken to domestic animals, especially pigs. He observed that the non-malaria-transmitting zoophilous north-European race of this species could be distinguished from the malaria-carrying south European form by its larger average size.

Legendre and Oliveau in the same year report that further experiments confirm their previously expressed views regarding the preference shown by *Anopheles maculipennis* towards the blood of rabbits.

This is followed by a paper by Roubaud and Leger in which it is stated that cattle in Corsica are as attractive to *A. maculipennis* as on the Continent. But that the mosquitos are not attracted in sufficient numbers as the buildings used for sheltering the animals are totally unattractive to the mosquito.

Wesenberg-Lond in a paper accounts for the increase in the size of the mosquito north of the Alps as due to the easy conditions of life and abundant nourishment in the cattle-sheds, while south of the Alps, where it is the chief malaria carrier, the domestic animals spend the greater part of the year out of doors.

Legendre subsequently noted that *A. maculipennis* has confirmedly strong attraction to rabbits and suggests the keeping of rabbits at home as a means of escaping the attentions of the mosquito.

Grassi in his paper on the New Horizon in Antimalarial Work in 1921 states that at Schito (Italy) *A. maculipennis* lives exclusively on domestic animals and that it is only under peculiar circumstances, *e.g.*, closed rooms and great hunger, that they bite man. He considers that it was as a result of the influence of a herd of cattle that existed between 1860 and 1885, that these mosquitos got accustomed to feed solely on domestic animals. So to-day, though the Anopheline is present in large numbers, malaria is absent in Schito. He considers that it would be a great mistake to destroy the mosquitos found inside cattle-sheds where they are to be found in large numbers. Some workers had previously suggested that these stables should be used as traps for attracting mosquitos in order to kill them every day. But Grassi thinks that by destroying those found inside the cattle-sheds, we would be eliminating those individuals which prefer animals to man.

Ed. and Et. Sergent are the first to dispute the theory of animal prophylaxis. They consider that the number of Anophelines is so great that the protection which the cattle afford is quite inadequate. Roubaud soon follows with a paper in which he says that the influence

of natural selection on mosquitos that feed on domestic animals has affected the mouth parts, particularly the dentition of the saw-like edge of the maxilla. The number of teeth averages about 13 in the normal man-biting mosquito from a malarious locality while, in districts where cattle are plentiful, an average of 15 teeth is found. In the latter districts, he says, malaria is absent. He therefore suggests that by the examination of the number of teeth on the maxillæ of mosquitos of a district, the liability to malaria of that district could be ascertained. Regarding the introduction of cattle into malarious districts as an anti-malarial measure, he thinks that it may not be of very great effect, as in such districts the mosquitos have not yet acquired a taste for the blood of cattle. If however, the introduction of cattle into a highly malarious district is accompanied by an introduction of Anophelines with a preference for cattle, the latter are likely to replace the original mosquito population.

Fry supports the view of Roubaud and suggests the formation of a ring of cattle-sheds around the village. He, however, points out that close association with cattle does not always prevent an epidemic and cites the case of the cattle-zone of the Amritsar City which suffered most during the Punjab Epidemic of 1908.

The theory of Roubaud receives a great rebuff from a paper by Sergent, Parrot and Foley which says that in Algeria out of a very large number of *Anopheles maculipennis* examined, over 46% had more than 14 teeth on the maxillæ. And besides, in 50% of the specimens, the number of teeth differed on the two maxillæ of the same individual, the difference being as much as three in some cases.

This was followed by a paper by Langeron who says that the theory of acquired preference of *Anopheles maculipennis* for the blood of cattle is not sufficiently established. The fact that the mosquitos are found in stables, etc., in large numbers is not enough. It is probably because of the darkness and dampness of these places, while human dwellings are well-lighted and dry. Neither does this mean that these mosquitos do not bite man. Even though mosquitos were found in ordinary rabbit-hutches, none were found in a hutch which was well-lighted and ventilated. He therefore thinks that the rôle of cattle is very limited in the prevention of malaria and that it is also counteracted by the supply of nourishment afforded to the mosquitos. Roubaud then replies to the criticisms of Sergent, Foley and Parrot, but his arguments are not convincing.

Schuffner and Hylkema state that in Java, buffalo-sheds are extraordinarily attractive to *Anopheles ludlowi* and other mosquitos. They

remark that a single buffalo has so much attraction as to attract away most of the *A. ludlowi* from the dwellings of 100 people.

Grassi subsequently expresses the opinion that the number of teeth on the maxilla of *Anopheles maculipennis* is unimportant and does not certainly bear any relation to the intensity of malaria of the locality. Though as a result of the attractiveness of cattle to mosquitos, man escapes to a certain extent, the value of cattle in the prevention of malaria should not be overestimated.

The last paper has been one by Martini in 1922. He considers that there is no basis for a supposition that there has been a change of instinct or of feeding habits in the mosquito. It should not be presupposed that *A. maculipennis* was in the habit of biting man in former times. The attacks of this mosquito are at night and are also painless and so records are rare of its man-biting powers. Individuals developed at low temperatures are larger than those developed at a high temperature. It is possible that the larger individuals have on the average a greater number of teeth. But there is no justification for separating them out as different races. But he however considers that the value of cattle in protecting man from this mosquito is certain. He thinks that a decrease in the number of cattle in a locality may have great effect on the prevalence of Malaria.

It will be seen that most of the observations summarized above refer to Europe and to *Anopheles maculipennis*. The attractiveness of cattle to these mosquitos has been judged mainly upon the number of mosquitos collected in stables, etc., and not on actual numbers found biting man or his live-stock. Even though it is possible that such numbers are true, there is no certainty why mosquitos which bite man at night cannot take shelter in cow-sheds in the morning, especially as the conditions in a cowshed are very favourable as regards moisture and darkness. The observations of Langeron are much to the point. In well-ventilated and well-lighted rabbit-hutches he found no mosquitos, while in ordinary hutches, dark and moist, he could get any number. It is not true that mosquitos always stay in the place where they feed. Bath-rooms are very favourite resting places for mosquitos in India and yet no one stays in such places at night. So, as the place of rest and the place of feeding are different in mosquitos, no reliance can be placed on the number of mosquitos collected from different places in the daytime in order to judge their feeding habits.

There has been no evidence to show that *A. maculipennis* was feeding on man in former times and that it has changed its feeding habits in recent times. The reduction in the prevalence of malaria in some parts of Europe may be due to any of the innumerable factors controlling the

prevalence of malaria. Sufficient observations are not available to call the north-European form a cattle-feeder, nor the southern form a human parasite. The size in the two forms is not very constant. Similarly also with regard to the number of teeth on the maxilla of the female mosquito. Sufficient data are not at hand to ascertain from the number of the teeth, whether an individual feeds on man or on cattle. Roubaud says that in non-malarious districts the number of teeth average 15, while in malarious districts it is about 13. The range is not much. Variations are also common, and, besides this, no correlation can be made with these and those individuals which have been definitely observed to bite man or animals. Sergent, Sergent, Parrot and Foley point out that out of a large number of specimens examined, over 50% of the individuals had varying numbers of teeth on their right and left maxillae, the difference being as much as 3 in some cases.

Another interesting fact should not be missed. Roubaud notes that in freshly-emerged specimens of *A. maculipennis* the number of teeth was 14·3 while in fully gorged ones it was 16·6. He evidently thinks that the additional teeth are subsequent adaptational formations. It is not clear how teeth can be formed on the highly chitinized maxillæ which are apparently fully formed when the adult emerges out of the pupa.

As already mentioned, most of the observations have been in regard to *Anopheles maculipennis*. To apply these observations, accepting them to be true to India or to the Tropics generally, would be ridiculous. This species has had such great attention on account of the fact that it is one of the very few species of *Anopheles* of Europe and has also been known to develop the malarial parasite. In India alone we have as many as 35 species of *Anopheles* with different habits, distribution and varying susceptibility to malaria. Of these nearly 50% have been known to transmit one or the other forms of the malarial parasites. The application of the principles of animal prophylaxis in India would be a very difficult matter. Firstly, it ought to be known whether it would be useful in the least. That would depend on the record of the habits of the different species of *Anopheles* which are the real transmitters of malarial infection in India. It would be only then that we would be able to say with some amount of precision whether the introduction of cattle or other live-stock would be able to attract away the malarious mosquitos from man and thus serve to reduce the chances of infection of a mosquito from man and of man from the infected mosquito.

It should be confessed that very little data are available regarding the feeding habits of the Indian *Anophelines* in spite of the great amount

of work done on this group of insects in this country. With the present amount of information available and the observations made by the writer, the *Anopheline* species of India may be divided into four groups based on their feeding habits :—

1. Species which are essentially wild, which attack only wild animals, and even domestic animals, but which attack man only very exceptionally.
2. Species which feed principally on animals and cattle but are known to attack man.
3. Species which principally feed on man, but also resort to animals and live-stock.
4. Species which are essentially feeders on man and which have not been known to attack animals except very rarely.

Though we are not able to ascribe particular species to the different groups owing to lack of precise knowledge, the above classification is quite acceptable and some species can, with our present knowledge, be assigned to the different groups. *Anopheles gigas, barbirostris, aitkeni,* and *lindesayi* are species which belong to the first group, and have been known to attack animals only and are mainly associated with them. They have not been known to bite man except very rarely. It is likely that all forest forms like *barianensis, asiatica, annandalei* and *culiciformis* also have similar habits. From their habits it is certain that none of these species are likely to be connected with the transmission by human malaria. But information on these species is greatly lacking. *A. barbirostris* very occasionally attacks man. I was once bitten by a female in the shade in the daytime.

The second group consists of species living on the blood of animals as well as that of man but with a strong preference for the blood of cattle. We could probably include the following species under this group :— *Anopheles hyrcanus* (*sinensis*), *fuliginosus, jamesi, maculipalpis* and *maculatus*. The European *A. maculipennis* is probably also under this head. If these species are transmitters of malaria of any locality, it would be easy to attract away these mosquitos by offering to them the blood of cattle which they prefer to that of man.

The third group consists of those species which feed on man as well as on cattle but show a preference for human blood. It is very difficult to formulate the species belonging to this group but it may not be wrong to place provisionally under this head the species like *Anopheles vagus, subpictus, jeyporensis* and also *culicifacies* which have similar habits, until such time as we are able to secure definite information on the habits of those mosquitos.

The provisional list of the species under the fourth head, namely those which live solely on human blood, includes *minimus*, *listoni*, *varuna* and *stephensi*.

It may not be out of place to note some of my observations on some of these species. At Courtallum, South India, where *Anopheles culicifacies* were plentiful, most of them were attracted to human dwellings mainly, though cattle-sheds were near about. In Singaran, near Raniganj, Bengal, a similar observation was made. No *Anopheles minimus* were to be found in the cow-sheds near a small house at Meenglas, Bengal Duars, though large numbers of them could be collected from inside the sleeping rooms next to them. The specimens of *Anopheles* collected inside the cow-shed were mostly *Anopheles maculatus* and some *A. vagus*. The cows were observed at night and the numerous specimens found biting them were collected and found to be mostly of *A. maculatus* with a few *A. vagus*. While collecting the specimens on the cattle, the collectors were not troubled by these mosquitos at all. But inside the rooms, into which we retired for the night, *A. minimus* attacked us with great avidity. This species was always to be found inside torn or badly used mosquito-curtains. In a single case as many as a dozen *A. minimus* were caught inside a curtain which had a few rents, under which a man slept. It was then found that not a single specimen of *A. minimus* would go to a cow while man was near about. Even though *A. maculatus* bites man, it does not appear to care for man when it is able to find cattle, etc., near about.

Such observations are not enough. Further observations are being carried out on an extensive scale to ascertain the relative feeding-habits of different species. The number of mosquitos attracted to a cow or any other animal at night should be caught and determined specifically and out of a large number of similar records over different districts with varying Anopheline fauna we shall be able to ascertain the relative food-preferences of the different species. The best method would be to tie a calf or a cow or any other animal under a large-sized mosquito curtain which is so tied as to allow about a foot of space underneath. The gap below allows ingress of the mosquitos. After their feed the mosquitos try to fly out and are kept within the curtain. The specimens caught in this way within the curtain are collected every morning and the trap set again in the evening. Different animals should be used and in some cases man also made to sleep under similar conditions. It is hoped to get sufficient data to enable us to form some idea of the food preferences of the *Anophelines* as a result of extended observations in different parts of Bengal.

Another line in which work is projected, is the collection of well-fed mosquitos from areas in which cattle and man are present and subsequently to test the stomach-contents of these mosquitos serologically to ascertain whether they contain human or mammalian blood. Major Lloyd, Serologist, has kindly promised to help us in the matter, which is indeed very kind of him considering the great difficulties in the way of examining such small quantities of blood.

The importance of these facts is mainly this. If the malaria-transmitting mosquito of a particular locality is of the second group it would be most easy for us to reduce the malaria appreciably by the introduction of cattle or other live-stock. If the species responsible for the malariousness of a locality is of the third group, *i.e.*, feeding both on man and animals but preferring man, we could also get some relief by the introduction of live-stock as, these animals being more easy to feed on, the mosquitos would also go to them. But if the malaria transmitter of the locality is one of the species which feed solely on man, cattle introduction would not serve the purpose of animal prophylaxis in the least.

In view of the above remrks, I wish to have the opinion of the members of this Meeting.

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There does not appear to be much known about cattle-biting mosquitos. At Muktesar I collected five species of *Anopheles* which were common in cattle sheds ; (*A. funestus var. listoni*, List ; *A. rossii*, G ; *A. willmori*, J; *A. lindesaii*, G; *A. maculatus*, T). Beside these, *Anopheles barianensis* was also found at Muktesar in a house, but not in cattle-sheds. It is not known to bite man or animals. In this connection I might refer you to a Bulletin issued from Muktesar on Malaria parasites in the blood of a buffalo.

A. fuliginosus, which is classed as attacking cattle in preference to man, is very common at Pusa as a sucker of human blood. There is a cattle-shed in the farm yard behind my bungalow, but, in spite of having many cattle so near, we are much troubled by this species of *Anopheles*. I have also been attacked by *A. barbirostris* in the jungle during the day time. The advisability, and even possibility, of introducing cattle with the view to deflecting attack to them from man seems open to doubt.

A cattle census is being taken in Bengal to determine the present position. In Bengal, *A. fuliginosus* is not a malaria carrier, and has not been recorded from man.

At Pusa it bites man freely, and there is thus a possibility that a species may fall into different classes in different localities.

In this discussion we must remember that along with an increase in the number of cattle many other factors are involved as possible causes of a diminution of the amount of malaria.

The theory was originally based on observations in Europe where an increase of cattle is often concurrent with an increase in agricultural prosperity, as is marked in Denmark, which is usually quoted as the chief example of the effect of cattle. Such an increase of prosperity would usually mean an increase of drainage and a clearing of " jungle "

which would affect the distribution of the insects. At the same time better social conditions and a higher standard of living would probably raise the resistance of the population to disease.

The presence of large numbers of *Anophelines* in cattle-sheds in the day time does not necessarily mean that these species are by preference "cattle-feeders". In this country in the small houses of the inhabitants any insects harboured in the houses are early in the day driven out by the activities and the culinary operations of the occupants and would probably take refuge in the adjacent cattle-sheds where they would be less disturbed and where the temperature and humidity conditions were probably more favourable, only to return to the attack on man during the night.

In Dera Ismail Khan *A. culicifacies* is by far the commonest mosquito found in cattle-sheds.

It seems a risky experiment to introduce a supposed " cattle-feeding " race of *Anophelines* into a district as we do not know that they will replace the local " man-feeding " variety but may be added to it. As the former variety is supposed to have developed from the latter we do not know that a reverse change will not take place under local conditions.

The following species are commonly found in cattle-sheds in Pusa :— *A. culicifacies*, *A. fuliginosus*, *Culex tritaeniorhynchus*, *C. vishnui*, and *C. gelidus*. I have been bitten by *A. fuliginosus* in the dairy compound, which shows that the presence of cattle does not afford protection.

In the Punjab, cattle are very numerous, and frequently occupy the same shelter with their owners at night, yet malaria seems to be as prevalent with us as in any other part of India.

Mr. Fletcher has asked me to make some remarks on the paper. I can speak only from the veterinary standpoint.

I would suggest to Mr. Iyengar that he might be able to improve upon his proposed method of experimentation, as his method of caging cattle under mosquito nets which do not reach the floor appears unlikely to afford conclusive results. It is necessary in experiments of this sort that they should be devised so as to leave nothing to chance.

If mosquitos exhibit any partiality for cattle it is because cattle are more placid, and the mosquitos are therefore less likely to be disturbed while feeding and not because the blood of cattle is more tasteful to them than human blood. I would suggest to Mr. Iyengar that he should study the change of habits of mosquitos normally affecting restive animals when more lethargic animals are made available for them. The Sergents have done a great deal of work on *Culex* mosquitos on pigeons and, by placing pigeon cages in the cattle-sheds, Mr. Iyengar could easily determine whether mosquitos do not drift from agile to lethargic species

Even should it be established that there is a preference for lethargic species, I do not see how it is going to influence the malaria problem, to any advantage. Where you keep cattle, you have to supply them with water, which will be placed in open drinking vessels. These vessels will always contain some water, which will breed mosquitos and tend to increase malaria.

Speaking from the standpoint of a veterinary pathologist, I certainly do not agree to our animals being used as mosquito attracters. Mr. Iyengar's paper is extremely speculative, and is not likely to lead to any useful conclusions.

I am doubtful of mosquitos having a preference for lethargic animals. A mosquito hunting blood is not easily deterred. and the efforts of the animal to drive it away do not seem to make much difference. Cats, for instance, are very sensitive about the ears, but they are very frequently attacked on the ears and. although there are humans in the room and the cat makes repeated efforts to drive away the insect, the mosquito ultimately succeeds in its purpose.

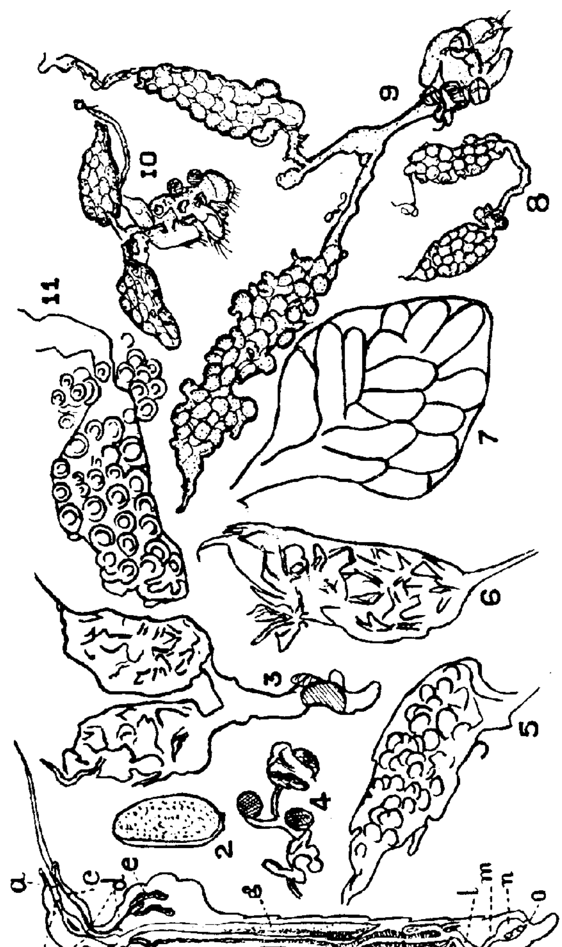
It appears likely that the higher normal temperature in animals may be the attracting principle, both in apparently specific and in general attacks.

As regards my faulty method of experimentation, it appeared to me the best I could devise as mosquitos attempting to reach the animal would come in under the hanging sides of the net, and after feeding, the bulk of them would fly upwards and remain inside the net, whence they would be collected next morning. Moreover, the conditions will remain identical when man or another animal replaces the cow. I should be glad if Mr. Edwards would give me some definite suggestions as to better methods of experimentation.

No evidence would be afforded by the method suggested of the attraction from man to cattle. It would be necessary to have a human being and a cow occupying the same net to observe the effect.

It must not be overlooked that if the number of cattle be increased they must also be fed, and there will therefore be less food for man.

The point raised by Mr. Husain has been in my mind from the outset of the discussion. I have the impression that India is already considerably overstocked with cattle, and that any further increase in numbers is undesirable, even if it were possible. Redistribution may of course be possible but before carrying out any extensive work on the lines Mr. Iyengar has indicated, it would seem to be advisable to obtain expert opinion upon these points, upon which the practical utility of the inquiry must rest.



Bionomics of *Aedes* (*Stegomyia*) *albopicta*. Skuse.

(An explanation of the figures is given on separate slip.)

EXPLANATION OF PLATE 16.

Fig. 1. Schematic longitudinal section of female mosquito (After Nuttall and Shipley) a, buccal cavity; b, pharynx; c, salivary duct; d, oesophagus; e, salivary glands; f, dorsal oesophageal diverticula; g, ventral oesophageal diverticula; h, oesophageal valve and caeca; i, midgut begins; i' midgut ends; j, "stomach"; k, malpighian tube; l, ileum; m, colon; n, rectum; o, anus.

2. An ovum of unfertilized *A.* (*S.*) *albopicta* dissected out eight days after it had bitten and sucked blood. (Drawn with Camera lucida). [Experiment 1].

3. Ovaries of *A.* (*S.*) *albopicta* fed on sugar solution only, the shaded portion being a piece of chitin that persistently adhered to the oviduct. In this case contours of ova could only be faintly discriminated under the microscope, the black lines representing merely detached bits of tracheae. (Drawn with Camera lucida) [Experiment 7].

4. Spermathecae detached from 3, the large one broke during manipulation. (Drawn with Camera lucida). [Experiment 7].

5. General appearance of one of the ovaries of a freshly emerged *A.* (*S.*) *vittatus*. (Drawn with Camera lucida). [Experiment 12].

6. General appearance of one of the ovaries of *A.* (*S.*) *vittatus* dissected out today after emergence and fed on sugar solution only. Contours of ova as in 3 (Drawn with Camera lucida) [Experiment 12].

7. One of the ovaries of *A.* (*S.*) *albopicta* fed on sweetened shed goat's blood for five days. (Drawn with Camera lucida). [Experiment 17].

8. Ovaries of unfertilized *A.* (*S.*) *thomsoni* fed on sugar solution for about ten days (Treated with Bless' solution and drawn from slides).

9. Ovaries of *A.* (*S.*) *albopicta* kept enclosed with males and fed on milk for about ten days. (Treated with Bless' solution and drawn from slide). [The ovaries got elongated during traction].

10. Ovaries of *A.* (*S.*) *albopicta* kept enclosed with males and fed on sugar solution for about ten days. (Treated with Bless' solution and drawn from slide).

11. Bubbles in the ventral oesophageal diverticulum in freshly emerged female *A.* (*S.*) *vittatus*. (Drawn with Camera lucida). [Experiment 12.]

31.—OBSERVATIONS ON THE BIONOMICS OF *AEDES* (*STEGOMYIA*) *ALBOPICTA*, SKUSE.

By S. K. SEN, B.Sc., *Assistant to the Imperial Entomologist.*

(Plate 16.)

The following observations relate to a connected series of experiments started with a view to finding out the rôle of blood in ovulation in Culicidae. While the main problem remains practically where it stood when the experiments were started, these incidental observations may be of interest in so far as they elucidate facts relating to the general bionomics of mosquitos and of *Aedes* (*Stegomyia*) *albopicta* in particular. In what follows the record of observations is practically transcribed from the note book wherein they were originally entered, and their bearing on the problem of ovulation is only lightly touched upon as occasion arises.

N.B.—(*a*) Cages designated by numerals, *e.g.* (4), were glass cages of the type used in previous experiments*; those by letters, *e.g.* (D), were cloth cages with wooden frames,

(*b*) In all the experiments there was always a supply of sugar solution within the cages for the mosquitos to suck; whenever blood has been introduced, the fact has been mentioned.

(1) Food. Sugar solution only.

28th August.—Isolated several pupae of *Aedes* (*Stegomyia*) *albopicta* and kept each separately in water in tubes.

30th August.—Enclosed one emerged female from above lot in cage (1) and another in cage (2).

31st August.—Enclosed a third emerged female in cage (3).

4th September.—Offered arm to all the three mosquitos twice at an interval of two hours, but none sucked blood.

5th September.—Offered arm thrice to each, but none sucked blood.

6th September.—They will refuse to bite arm when offered. None of the mosquitos appear to be full fed with sugar solution.

Changed disc, water and sugar solution. Offered arm again to mosquitos in cage (1): it sucked my blood at 2·45 P.M. Mosquitos in (2) and (3) sucked my blood at about 3 P.M. (Noticed that a convenient method of attracting and inducing them to suck blood is to exhale on the cloth of the cage).

* S. K. Sen, "A preliminary note on the role of blood in ovulation in Culicidae," *Indian Journal of Medical Research*, Vol. IV, p. 732 f. 2 (1927).

7th September.—Introduced two newly emerged males into cage (1). No mating noticed at least within fifteen minutes from the time of their introduction.

13th September.—Female in cage (2) found dead, apparently due to want of water in the bowl. Dissected it at 10 A.M. in normal saline : Ova found in fairly mature condition. Oesophageal diverticula full of bubbles.

14th September.—Killed mosquito in cage (3) and dissected out the ovaries and sketched an ovum (Fig. 2) : chorion distinct ; follicular membrane disintegrated causing ova to be separated during traction ; cytoplasm uniformly distributed leaving a more or less free border all through, and not concentrated at one end, as in mosquitos dissected 14 hours after feed. No trace of the imbibed blood in the system. Diverticula distended with numerous bubbles.

20th September.—Female in cage (1) found dead.

(2) Food. Sugar solution, afterwards blood.

1st September.—Confined five females and ten males of *A.* (*S.*) *albopicta* (all bred) in cage (D).

4th September.—Fed two females on my blood at 2 P. M. Viewed in reflected light under a magnification of X10, (*a*) one looked quite full of blood, (*b*) the other had the anterior portion of the stomach full of a clear liquid (apparently sugar solution), the level of the imbibed blood sloping away from the end of the third segment of the dorsal side to the commencement of the fourth segment on the ventral. Killed specimen (*a*) with chloroform, removed wings, legs and head and placed the rest of the body in Bless solution. Dissected specimen (*b*) in normal saline and removed the whole alimentary tract and also the ovaries in detached condition and fixed in Bless solution : no trace of blood anywhere except for a small portion of the foregut, the entire quantity of the imbibed blood being almost exclusively contained in the "stomach," the walls of which were very thin and numerous blood-corpuscles were streaming out in the saline during manipulation ; Malpighians brittle (? due to overhardening in Bless) ; the stomach was too distended to be mounted on a plain slide in the ordinary way.

5th September.—(*a*) Of the remaining three females in cage (D) two noticed to be destroyed by a spider (which had been in hiding inside the cage, behind the wooden frames). The one left displayed extraordinary hunger for blood, keeping close to

my body or hand as I leaned over the cage. Coloured some water with eosin and heated to 37°C, poured it in a "Thermos" flask the cork of which was replaced by a piece of muslin securely tied up so as to prevent water from falling while permitting the mosquito to insert its proboscis through the meshes; offered the heated water to the mosquito in various position but it did not suck.

(*b*) Transferred specimen (*a*) of yesterday from Bless solution to a solution of paraffin in chloroform.

5th September.—Placed the above prepared "stomach" [specimen (*a*)] in paraffin bath (m.p. 58°—59°C) for three hours.

7th September.—Placed same in paraffin bath again for about two hours, and prepared the block.

9th September.—Cut sections with a Cambridge Rocker, each 6μ thick (the whole material came to about 189 sections) [ordinary paraffin, purified through a hot metal funnel, cut well] and arranged the sections on slides with Mayer's fixative freshly prepared, but the small quantities of blood in the sections dropped off during subsequent operations.

(3) Food. None.

4th September.—Dissected out the ovaries and alimentary tract of a bred female *Culex fatigans* and attempted to trace the fungus after staining with cotton blue, but none could be found.

(4) Food. Sugar solution only.

6th September.—Enclosed one female and two males (all newly emerged) of *A.* (*S.*) *albopicta* in cage (E).

7th September.—Removed them to cage (4).

8th September.—Offered arm for biting, but it did not bite.

10th September.—Offered arm again, but it did not bite.

14th September.—Dissected the female: Noticed that the largest of the three spermathecae revolved as if on a pivot (the rotation seemed caused by the peristaltic movements of the ovaries in normal saline); the cessation of rotation synchronized with the cessation of the peristaltic movements of the ovaries. Observed the intimate association of the Malpighians with the ovaries by means of extensive tracheal ramifications. No bubbles were noticed either in the diverticula or stomach.

(5) Food. Blood.

7th September.—Enclosed two newly emerged females of *A.* (*S.*) *albopicta* and three newly emerged males of same in cage (E).

One of the females appeared very hungry for blood, and would stab on the side of the cage where I happened to place the arm.

8th September.—Enclosed several males and females of *A.* (*S.*) *albopicta* (newly emerged) in cage (C).

15th September.—The only surviving female in cage (C) very hungry and sucked my blood (it took not less than two minutes to feed). This female and one male from cage (E) enclosed together in cage (3).

26th September.—It laid about 54 eggs.

27th September.—Set apart five batches of eggs of three each in pieces of 3″ square dry filter paper.

28th September.—Set apart five more batches as yesterday.

29th September.—Set apart five more batches.

30th September.—Eggs that had been allowed to remain in water found hatched.

7th January 1923.—All the above eggs set apart and kept under desiccated conditions found shrivelled up and did not hatch when placed in water.

(6) Food. Nil.

8th September.—Dissected one newly emerged male *A.* (*S.*) *albopicta* : "stomach" fully distended with bubbles.

(7) *8th September.*—Dissected another male : "stomach" as in the last, but not clear.

(8) *9th September.*—Dissected a pupa of *A.* (*S.*) *albopicta* : Failed to discover any bubbles.

(9) Food. Blood.

12th September.—Fed a captured *A.* (*S.*) *albopicta* on my blood and dissected out the alimentary tract and ovaries immediately (*i.e.*, about 30 seconds after feed) : Noticed *traces* of blood along the whole oesophagus and the ventral oesophageal diverticulum and one of the dorsal diverticula (the other could not be located) was full of blood and bubbles ; outline of ova defined, but cytoplasm not concentrated at any one end, but uniformly distributed.

(10) Food. *Nil.*

12th September.—Dissected a captured female *A.* (*S.*) *albopicta* noticed that the three oesophageal diverticula are distinct and full of bubbles ; ovaries enlarged but ova not developed.

(11) Food : *Nil.*

16th September.—Dissected two captured females and one male of *A.* (*S.*) *albopicta* : Malpighians five in number ; hardly

any bubbles in the diverticula in females, but many in males ; ova very small.

(12) Food. *Nil.*

15th September.—Procured some larvae and pupae of *A.* (*S.*) *vittatus.*

17th September.—(*a*) Dissected one freshly emerged female : the ventral oesophageal diverticulum full of bubbles (f. 11)

(*b*) Dissected out the ovaries of another freshly emerged female (f. 5)

19th September.—(*c*) Dissected out the ovaries of a female emerged on 17th September. (f. 6).

(13) Food. Blood.

17th September.—Fed an emerged female *A.* (*S.*) *vittatus* on my blood.

19th September.—Dissected out its ovaries : No trace of blood in midgut or anywhere ; ovaries did not appear to have advanced in maturity.

(14) Food : Blood.

25th September.—Confined a large number of males and females of *A.* (*S.*) *albopicta* (all bred) in cage (B).

29th September.—Fed eight female *A.* (*S.*) *albopicta* from the above lot at 10 A.M. *simultaneously* on my blood. Confined six of them singly with water only (to see difference in ovulation periods) in cages (1), (2), (3), (4), (5) and (6).

3rd October.—Many eggs laid in (5) and some in (4) ; none in the rest.

4th October.—Mosquito in (4) and (5) found dead.

7th October.—(*a*) Mosquitos in cage (2) laid eggs.

(*b*) Eggs laid in (4) and (5) not yet hatched.

9th October.—(*a*) Eggs, except a few, laid in (5) found hatched. Transferred larvae to water procured from actual breeding places of *Aedes* (*Stegomyia*).

(*b*) Placed three eggs from each of the cages (4) and (2) in Bless' solution.

10th October.—(*a*) Several of the numerous eggs laid in cage (2) found hatched.

(*b*) Four of the six eggs placed in Bless' solution yesterday found hatched and the emerged larvae dead.

16th October.—One larva of (*a*) of 9th October pupated to-day. The life cycle of this lot was found to be as follows :—

Incubation period	. 6 days	(3rd October to 8th October)
Larval period .	. 8 days	(9th October to 16th October)
Pupal period .	. 3 days	(17th October to 19th October):

(15) Food. *Nil.*

29th October.—Dissected one newly emerged male *Lutzia fuscana*: Five Malpighians; the prominent ventral oesophageal diverticulum full of bubbles.

(16) Food. Shed goat's blood sweetened with sugar.

2nd October.—Enclosed several emerged males and females *A.* (*S.*) *albopicta* in cage (C).

3rd October.—Many (both males and females) appear to have taken full feeds.

6th October.—Fresh sweetened shed blood supplied.

9th October.— Do.

13th October.— Do.

14th October.—Added several captured males: some commenced mating immediately.

15th October.—Blood could not be procured.

19th October.—Fresh sweetened shed blood supplied.

20th October.—Only one female remained (some being killed for other purposes).

21st October.—The female found dead. Dissected out the ovaries and found well formed, black eggs.

(17) Food. Goat's blood sweetened with sugar.

4th October.—Enclosed some emerged males and females of *A.* (*S.*) *albopicta* in cage (D).

6th October.—Fresh sweetened shed blood supplied.

9th October.— Do.

11th October.—Dissected out the ovaries of one female: Ova found almost mature (f. 7).

13th October.—Fresh sweetened shed blood supplied.

14th October.—Added many captured males.

19th October.—Fresh sweetened shed blood given.

21st October.—The only surviving female found dead.

(18) Food. Shed goat's blood sweetened with sugar.

26th October.—Introduced freshly emerged males and females of A. (*S.*) *albopicta* in cage (E) [Arranged with butcher for a daily supply of fresh blood].

27th October.—Fresh sweetened shed blood supplied One female found dead on water in the bowl.

28th October.—Blood not supplied to-day.

29th October.—Fresh shed blood supplied.

30th October.— Do.

31st October.— Do. Only one female and two males survive.

1st November.—Fresh shed blood supplied.

2nd November.—Fresh shed blood supplied.

3rd November.—No blood supplied. No eggs laid as yet. Experiment discontinued.

Except for the reproductive system, the internal anatomy and histology of the more important parts of *Anopheles maculipennis* have been dealt with and illustrated in the standard paper of Nuttall* and Shipley. The internal anatomy of *A.* (*S.*) *albopicta* does not materially differ from that of *Anopheles maculipennis* (f. 1.), and, so far as the alimentary tract is concerned (including the disposition of the three oesophageal diverticula), no difference could be made out between the male and female *A.* (*S.*) *albopicta.*

The presence of a fungus, supposed to belong to the Entomophtoracae (Mycetae), demonstrated by Schaudinn, and referred to by Dr. Duree† and other authors, could not be detected although it must be stated that only a few attempts were made to find it, and the failure might also be due to faulty technique (it is however, proposed to study the nature of the fungus more closely). It is just possible that the symbiotic character of the fungus, its rapid multiplication in blood and its reported presence throughout the whole system (including the ovaries themselves) may have some relation to ovulation.‡

There is a considerable difference of opinion with regard to the function of the oesophageal diverticula, and with regard to their number. Giles would count them as two while Nuttall and Shipley definitely state their number as three. So far as *A.* (*S.*) *albopicta* is concerned, they appear to be three in number.[4] As regards their function, while it must be admitted that the experimental evidence produced by Nuttall and Shipley demonstrate that they are of the nature of food-reservoirs, the observations recorded in this paper are too few to warrant any such definite conclusion, but so far as these few observations are concerned only in a few instances were traces of blood noticed in them after feeds

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* *Journal of Hygiene*, Vol. III, t. 6 f. 1 (1903).

† Mitchell. *Mosquito Life*, p. 6 (1907).

‡ The precise function of such symbiotes appears to be far from well understood. Roubaud explains their function in *pupiparous* insects as follows, "All pupiparous Diptera are provided with intestinal symbiotes and are strictly haemophagous, these three characteristics having a distinct inter-relation. Without the intervention of the symbiotes in the digestion of blood taken in by the fly, the elements of water would not be present in sufficient quantity to allow of an exclusive diet of blood. The natural result of this symbiotic haemophagy is pupiparity." *Ann. Inst. Pasteur, Paris*, XXXIII pp. 489-536, ff (Aug. 1919). [Extract from *Rev. App. Entom.* Ser. B. VII, p. 174 (1919)]

[4] Pressat (1905) cautiously states, " de diverticules sacciformes, au nombre de deux ou trois, qui sont ou des jabots accessoires destinés contenir une reserve nourriture, ou peut-être des organes compensateurs du reflux de sang vers le pharynx." *Le Paludisme et les moustiques*, p. 55.

of blood. Pending further work, therefore, on the subject, de Grandpre's terminology (namely "oesophageal diverticula") has been adopted in preference to Nuttall's ("food reservoirs") in order to avoid using a term that might ascribe to the organs a definite functional character.

The presence of bubbles in the sacs has been the subject of much speculation. Nuttall and Shipley write, "The bubbles are not as yet explained. They must have their origin from the outside, that is they must come in through the mouth-parts, either in the process of feeding or afterwards. During feeding air might very well enter if the pumping action of the pharynx, &c., were continued even for a moment after the removal of the probocis from the fluid which is being ingested. The small size usually shown by the bubbles argues in favour their having been carried through the small oval aperture. We propose to pursue this subject which is of considerable interest."[5]

It would appear to be open to question whether the entry of the bubbles into the diverticula is effected exclusively or even partially through the medium of food, in view of the fact that their presence was detected in specimens dissected out immediately after emergence (Experiments 6, 12). In some instances bubbles were noticed throughout a large part of the alimentary tract and the diverticula of freshly emerged mosquitos (Expt. 12) before, apparently, they had taken a feed of any material in the breeding vessel.

Eysell's observations (1907)[6] on this point accord to a large extent with those of the writer of this paper. He writes, "During the pupal stage the diverticula contain no air whatever, in the newly emerged imago they are on the contrary dilated with air." He further says, "The air is in part swallowed, as one can observe in emerging mosquitos by the increasing inflation of the abdomen and the movements of the pharynx-pump." Stephens and Christophers,[7] in addition to the function of the large diverticulum (ventral) as an "air-chamber to specifically lighten the body of the mosquito" speak of its further property of "distributing the pressure of the large coagulum formed in the midgut after feeding." While the formation of these bubbles within the diverticula is thus more or less explained, their economic significance in the life of a mosquito does not appear to be understood, although their partial function may be of the nature indicated by Stephens and Christophers.

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[5] *Journal of Hygiene*, Vol. III, p. 177 (1903).

[6] *Archiv fur Schiffs und Tropenhygiene*, Vol. II [Quoted by Howard, Dyar and Knab, *The Mosquitos of North and Central America and the West Indies*, Vol. I, p. 79 (1912)]

[7] *The practical study of Malaria and other blood parasites* (1908). It should be however observed that the two dorsal diverticula must have a very different function as they are distant from the midgut.

While, therefore, as stated by Nuttall and Shipley, the tracheal supply of the diverticula is extremely poor, as compared with that of the other parts of the mosquito's system, the theory of their pneumatic function, as advanced by Giles[8] and opposed by Nuttall and Shipley, does not appear to be altogether untenable although, secondarily, they may serve as food-reservoirs. It stands to reason that an essentially terrestrial adult insect, which oviposits directly in water and emerges from the puparium in water,[9] should have something else to rely upon other than the specific gravity of its own body and the surface tension of water. This lacuna may be compensated for, to some extent, by the air contained in these sacs.[10]

It should be noted that the presence of bubbles is a matter very different from the presence of mere air. In the former case the presence of a liquid is indispensable for the formation of bubbles and a somewhat complex set of circumstances arises from their surface tension. It is not improbable that one other function of the bubbles may be to enable the mosquito to balance itself, as in no other insect does a more accurate poising seem called for than in the mosquito, whether during feeding, egg-laying or emergence from the puparium. The relative adjustment of the bubbles during varying postures would ensure a very acurate equilibrium and the elasticity of the bubbles would, to a large extent, prevent their exit, although permitting of the occasional entry of the imbibed liquid food, and the extremely thin walls of the diverticula (as can be observed on dissection) can hardly exert a weight sufficient to break the bubbles.[11]

With regard to the effect of food on ovulation, it has been already pointed out in a previous publication[12] that in a few instances oviposition followed an exclusive diet of substances other than that of blood, but in most cases no oviposition occurred, the effect of such a diet as milk,

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[8] *A Handbook of the Gnats or Mosquitos*, pp. 104-106 (1902). The correlation of the degree of ovulation with the amount of air present in the diverticula, as suggested by Giles, has not been studied by the writer of the present paper.

[9] In this respect Culicidae and Chironomidae would appear to occupy an unique position, for with most other insects (*e.g.*, Tabanidae) whose larval stages are passed in water oviposition takes place in comparatively dry places, and the pupal stage is also passed in moist or at most semi-aquatic situations, while *Simulium* pupae, unlike the free-living pupae of mosquitos, are anchored on to stones, &c.

[10] Cf. *Culex* egg-masses, "The mass has a certain repellent quality, inherent, it seems, in a covering of delicate air-cells on the under surface." Howard, Dyar and Knab, *loc. cit.* p.142, although the mechanism, which chiefly relates to surface tension, is different in this case.

[11] A consideration of this interesting aspect of the question is out of the scope of the present paper. Reference may however be made to *Soap Bubbles* by C. V. Boys, F.R.S. (Romance of Science series) p. 50 *et seq* (1896), and to Miall's *The Natural History of Aquatic Insects*, pp. 12-18 (1903).

[12] *Indian Journal of Med. Research*, Vol. IV, pp. 729-753 (1917).

being as represented in Figs. 8-10. A more systematic procedure appeared to be to study the effect of shed blood, and, if ovulation resulted from such a diet, to find out the actual constituent of blood responsible for it. But from Experiments 16 and 17 it would appear that although the ova attained maturity with meals of shed goat's blood, no oviposition occurred. The whole or most part of the digestion of blood appeared to take place in the "stomach" (Expt. 2), as after a meal of blood hardly any traces of it were noticeable either in the foregut or in the ileum[13], and except for the tracheal branches, some of which intimately anastomose with the ovaries, there does not appear to be any other direct connexion between the alimentary tract and the ovaries.[14] The general appearance of the ovaries under varying conditions is indicated in the figures.

Experiment 8 was undertaken to study the effect of absolute and prolonged desiccation on the eggs of *A.* (*S.*) *albopicta*, and their allotment into batches was made with view to correlating the period of their initial contact with water when laid, with the period required for hatching when subsequently replaced in water. As observed by Lamborn[15] in the case of Malayan Anophelines, a moist environment appears to be absolutely necessary for the eggs to retain their viability.

Experiment 18 shows the extent of variation in the ovulation period in individual mosquitos which emerged from puparia almost *simultaneously* and fed on blood *simultaneously*.[16]

Incidentally Experiment 18 shows that under almost natural conditions the life-cycle of *A.* (*S.*) *albopicta* from oviposition to emergence of the adult is 17 days in October at Pusa.

The Isolation of pupae in Experiment I was done with a view to ensure against mating amongst newly emerged mosquitos in order to study the effect of food on ovulation, independent of fertilization.

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[13] Stephens and Christophers also found this to be the case, *loc. cit.*

[14] The following references are taken from Gordon's "Notes on the bionomics of *Stegomyia calopus*, Meigen, in Brazil," *Ann. Trop. Med. and Parasit.*, Vol. XVI, pp. 425-439 (Dec. 1922):—Otto and Neumann in Brazil obtained fertile eggs by feeding *Stegomyia* on blood and salt solution, *Zeit Hyg. Infectionskr.* Vol. LI, p. 357 (1905); Bacot, in West Africa, on two occasions obtained single eggs by feeding the mosquitos, on one occasion on honey and blood, and on the other on syrup and blood, one of these eggs proving fertile, *Yellow Fever Commission Report*, Vol. III (1916): Marchoux and Simond, at Rio, obtained negative results, in the case of *Stegomyia* with fresh human serum, red cells separated by centrifuging and blood clot, *Ann. Inst. Pasteur*, Vol. XXV, (1906); Gordon himself obtained negative results with serum, washed red cells (diluted with normal saline), but positive results in three cases with whole blood (diluted with saline), pp. 454-435. Young obtained negative results, in the case of *A. argenteus*, with peptone and sugar, but Fielding obtained positive results with these substances, *Ann. Trop. Med. and Parasit.*, Vol. XVI, (Dec. 1822) and Vol. XIII (1919) respectively.

[15] *Bull. Ent. Res.*, Vol. XIII, pp. 129-149 (Nov. 1922).

[16] Cf. Lamborn's observations (*loc. cit.*) on simultaneous hatching under varying conditions and irregularity in hatching under laboratory conditions.

Experiment 3 (*a*) was for studying the effect of heat (body temperature) on the *sucking* (and not merely *biting*) propensities of *A.* (*S.*) *albopicta* and the liquid was coloured red in order that any imbibed material might be detected through the transparent chitin of the abdomen.

Summary of the more important observations :—

(1) No eggs were laid by adults fed on fresh shed goat's blood sweetened with sugar, although the ova appeared to be mature.

(2) Mosquitos dissected out very soon after feeds of blood showed the imbibed food almost exclusively in the "stomach."

(3) No eggs were laid by unfertilized *A.* (*S.*) *albopicta* although allowed to bite and suck blood.

(4) *A.* (*S.*) *albopicta*, dissected out immediately after emergence as also after feeds, showed large numbers of bubbles in all the three oesophageal diverticula and sometimes in the alimentary tract. Bubbles were found in both males and females and also in *Lutzia fuscana*, Wied. and *A.* (*S.*) *vittatus* Bigot.

(5) Eggs lost their viability on being subjected to prolonged desiccation.

(6) Warmth and exhaled carbon dioxide activated female *A.* (*S.*) *albopicta*.

(7) Females of *A.* (*S.*) *albopicta* emerged and fed simultaneously oviposited at different periods.

(8) The life-cycle of *A.* (*S.*) *albopicta* from oviposition to emergence of adult was found to be seventeen days in October at Pusa.

32.—CARBON BISULPHIDE NOT EFFICACIOUS AS A MOSQUITO LARVACIDE.

By T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S., Imperial Entomologist.

In a recent number of the *Journal of Economic Entomology* (XV. 373; Oct. 1922), Mr. A. K. Fisher, in a note on the value of Carbon Bisulphide in combating Tent Caterpillars and Mosquitos, stated that "a few drops" put into a ten-gallon tub swarming with mosquito larvae killled them all in half-an-hour without imparting the least taste or smell to the water. For use in India, Carbon Bisulphide would hardly be practicable on any scale on account of the difficulties connected with obtaining it and the undesirability of leaving its application in untrained hands, but it seemed interesting to test its value as a mosquito larvacide. I therefore took a large tank holding about five gallons, filled it to the brim with water, introduced a mixed lot of Culicine larvae (mostly *Aedes albopictus*) and dropped in "a few drops" (about half-a-dozen) of ordinary Carbon Bisulphide. These drops sank to the bottom of the water and remained as flattened, well-defined globules. After forty-eight hours, the mosquito larvae were quite lively, except for a few normal casualties, and the globules of Carbon Bisulphide were still present, although somewhat reduced in size. Observation showed that these globules, when in water, generate small bubbles of gas which rise and escape through the surface. It seemed possible therefore that the lethal action might be due to an accumulation of this gas on the surface of the water, if this did not fill the container, the gas poisoning the larvae directly through their respiratory organs. To test this, I took another similar glass tank and filled it about one-third full of water and then introduced mosquito larvae and Carbon Bisulphide as in the first tank. Examination after twenty-four hours showed the larvae still active and only a very faint trace of smell of Carbon Bisulphide on top of the water.

As the failure of the experiment might have been due to an insufficient use of Carbon Bisulphide, a larger quantity (about a cubic inch) was then placed in both jars, in one case simply dropped in, when it spread out in globules on the bottom of the jar, and in the other case placed in a tube one-inch wide stood open-mouthed on the bottom of the jar. In neither case was any lethal effect produced, as in the preceding experiments; with regard to this statement, however, I must except a few larvae which were killed by coming into direct contact with the

surface of the Carbon Bisulphide. In the case of the open-mouthed tube, for example, five or six larvae were found dead in this and had evidently wriggled against the surface of the Carbon Bisulphide by accident when swiming downwards from the surface.

We may conclude, therefore, that Carbon Bisulphide, at least of the quality available in India, is not effective as a larvacide for mosquitos.

33.—AIRTIGHT STORAGE OF GRAIN.

By HARNAM DASS BHASINE, M.Sc., *Officiating Assistant Professor of Zoology, Punjab Agricultural College.*

The presence of adults as well as larvæ of insects in biscuit and oatmeal tins and in such other receptacles, supposed to have been soldered so completely as to make them airtight, was responsible for the opinion, held till recently, that these insects could live and multiply, for a long time, quite independently of fresh air and continue their devastating activities.

Professor Cole in his paper "On the Bionomics of Grain Weevils" (1906) made the following noteworthy statements :—"A non-ventilated atmosphere at about 80°F. charged with water vapour (no matter how poor in O_2, and contaminated with CO_2) provides the most favourable conditions for the life and reproduction of these weevils." He concluded by saying :—"In face of these and my other results, it would be absurd to hold either that weevils require a free play of air or even that free excess of air when possible is favourable to existence." It is true that high temperature favours the development and multiplication of grain weevils or other insects, and that a certain degree of humidity provides the best condition for their life, yet the above statement, so far as it minimizes the importance of Oxygen for the maintenance of life and its activities, appears to be tinged with exaggeration.

In 1888 Cotes collected some information on the subject of Air-tight Storage. He was of opinion that "Wheat stored, so as to be practically air tight, is said to be free from the attack of weevils." He believed that wheat stored in pits or mudbins and covered with earth at the top remains quite sound even when stored for three years. This practice of underground storage is actually followed at the present day by people at Amballa and Karnal, where they store wheat in *Khattis* (pits dug out in the open and lined with leaves of trees). The wheat thus stored is said to remain sound for a year at least. Cotes had so much confidence in his views that he went so far as to assert that "Ventilation causes the grain to be more infested by weevils, as wheat packed in bags gets more weevilled than wheat stacked in bulk or pile which is more airtight." He further adds "Ventilation and stirring the grain about appears to develop the pest." He concludes by saying "The only method to prevent destruction of grain from the weevils is to make the granary airtight."

Professor Dendy (from whose reports the above remarks and quotations have been taken) was the first to start scientific investigations on the life of grain weevils under airtight conditions. The results of his investigations have been published in the Reports of the Grain Pests (War) Committee of the Royal Society, No. 1, entitled " Reports on the effect of airtight storage upon grain insects." He says, " Within limits of a wide range of conditions as to temperature, moisture and degree of weevilling, hermetical sealing is a very effective method of dealing with weevil problem."

Experiments conducted along lines suggested by Professor Dendy on *Trogoderma khapra*, the commonest pest of grain in the Punjab, confirm his results on *Calandra oryzæ*, and other grain pests.

Glass Flasks, varying in capacity from 60 c. c. to 1,150 c. c., were selected for different experiments. They were filled with wheat of different types (see table A) and a known number of the larvæ of *T. khapra* were introduced in each : the flasks were then corked and sealed with paraffin and made absolutely airtight : each flask was then dipped in hot water to test if it was airtight. To facilitate observation a known number of larvæ were also placed in these flasks in small glass tubes with muslin tied round the mouth and a few grains of wheats put in as food. In all the experiments (except two doubtful cases) the insects died in less than a month under these conditions of airtight storage. In the corresponding controls, where the flasks were not made airtight, the insects lived, developed and multiplied unchecked.

In India, unlike England and America, almost all people prepare their own bread, grind their own flour and store their own wheat, and we attempted to see if such a simple process as airtight storage could not be made available for such people. It is well known that wheat containing insects stored either in ordinary earthen pitchers capable of holding four to six *seers* of wheat or in large mud bins, gets badly damaged, and this damage continues even when wheat is stored for years. Experiments were performed to find out if by some process these pitchers could not be made airtight. (see Table B). Pitchers were coated with paraffin wax and coal tar, and these were the best airtight conditions we could get, yet after more than a year of storage living insects were found in the grain. It seems, therefore that an airtight condition either is not so easy to obtain or does not work on a large scale. In glass flasks filled with grain and made airtight, the amount of air is probably very small, no exchange of gases with outside is possible, therefore the atmosphere becomes vitiated very soon with CO_2, and, all the available Oxygen being exhausted, the insects die. This absence of O_2 in glass flasks kills weevils in all stages of their development. In the case of earthen pitchers,

however, such airtight conditions cannot be attained and moreover when we are dealing with larger quantities of grain, it seems probable, that the air that occupies the interspaces of the grain, is sufficiently large to continue to keep the atmosphere of a pitcher suitable for the life of the grain insects for a very long time.

Another series of experiments was started to store attacked wheat in flasks in an atmosphere of CO_2. (See Table C.) This was effected as follows :—

In each case a flask was half filled with attacked wheat and a lighted candle was placed inside and the flask was made airtight. The candle burnt so long as there was O_2 present in the atmosphere of the flasks, which was sealed at this stage with paraffin. The insects in the flask were found dead after a few days, whereas those in the control flasks were hardly affected. It seems therefore that CO_2 hastens the death of weevils in the airtight receptacle, but insects die in it for want of O_2. Carbon dioxide in itself does not seem to be poisonous as in one experiment larvæ of *T. khapra* remained in an atmosphere of CO_2. for four days and appeared to be apparently dead, but when they were taken out of CO_2 atmosphere on the fifth day they revived within twentyfour hours. In some other experiments CO_2 was produced by means of a Kipps apparatus.

Similar experiments were also performed with metal tins able to hold about fifteen *seers* of wheat and sealed airtight. The time required to kill weevils was generally less than a month (See Table C). The controls were also kept for these experiments and insect life continued in these.

The use of CO_2 has been recommended by many authorities in Australia ; this gas is pumped into a store for a time to destroy all traces of weevils. With a view to practical utility of this process, a number of grains of various types of wheat common in the Punjab were kept in separate flasks in an atmosphere of CO_2 for a period of five months and the results of germination (See Table D) seem to indicate that the grains remained quite sound.

Work along these lines will be continued.

TABLE A.

No.	Capacity of vessel.	Date of sealing.	Date on which opened.	Condition of control experiment.	No of larvæ introduced.	Results effect on larvæ.	Type of wheat used.
1	60 C. C. glass flask.	3rd March 1921	2nd May 1921	Insects living and moulting.	10 ♂ 10 ♀	Dead.	I type.
2	Do.	Do.	Do.	Do.	Do.	Do.	II ,,
3	Do.	Do.	Do.	Do.	Do.	Do.	III
4	Do.	Do.	Do.	Do.	Do.	Do.	IV ,,
5	Do.	Do.	Do.	Do.	Do.	Do.	V ,,
6	Do.	Do.	Do.	Do.	Do.	Do.	VI ,,
7	Do.	Do.	Do.	Do.	Do.	Do.	VII ,,
8	Do.	Do.	Do.	Do.	Do.	Do.	VIII ,,
9	Do.	Do.	Do.	Do.	Do.	Do.	IX ,,
10	Do.	Do.	Do.	Do.	Do.	Do.	X ,,
11	Do.	Do.	Do.	Do.	Do.	Do.	XI ,,
12	Do.	Do.	Do.	Do.	Do.	Do.	XII ,,
13	600 c. c.	28th June 1921 not sealed.	5th September 1921	Do.	20 ♂ and 20♀	Living	Farm wheat.
14	Do.	Do. sealed	4th August 1921	Do.	Heavily attacked wheat.	Dead	Bazaar wheat.
15	Do.	Do.	5th September 1921	Do.	Do.	Do.	Do.
16	Do.	Do.	Do.	Do.	Do.	Do.	Do.
17	Do.	10th September 1921	17th October 1921	Do.	Do.	Do.	Farm wheat.
18	Do.	Do.	Do.	Do.	Do.	Do.	Bazaar wheat.
19	Do.	Do.	Do.	Do.	Do.	Do.	Do.
20	Do.	Do.	Do.	Do.	Do.	Do.	Do.
21	1,150 c. c.	Do.	Do.	Do.	Do.	Do.	Do.
22	Do.	Do.	Do.	Insects Living	50 ♂ 50♀	Do.	Montgomery type
23	Do.	Do.	Do.	Do.	Do.	Do.	Bazaar wheat.
24	Do.	Do.	Do.	Do.	Heavily attacked.	Do.	Do.
25	60 c. c.	26th July 1921	31st August 1921	Do.	10 10	Do.	I type.
26	Do.	Do.	Do.	Do.	Do.	Do.	II ,,
27	Do.	Do.	Do.	Do.	Do.	Do.	III ,,
28	Do.	Do.	Do.	Do.	Do.	Do.	IV ,,
29	Do.	Do.	Do.	Do.	Do.	Do.	V ,,

TABLE A—*contd.*

No.	Capacity of vessel.	Date of sealing.	Date on which opened.	Condition of control experiment.	No. of larvæ introduced.	Results effect on larvæ.	Type of wheat used.
30	60 c. c.	26th July 1921	31st August 1921	Insects living and moulting.	10 10	Dead.	VI type.
31	Do.	Do.	Do.	Do.	Do.	Do.	VII ,,
32	Do.	Do.	Do.	Do.	Do.	Do.	VIII ,,
33	Do.	Do.	Do.	Do.	Do.	Do.	IX ,,
34	Do.	Do.	Do.	Do.	Do.	Do.	X ,,
35	Do.	Do.	Do.	Do.	Do.	Do.	XI ,,
36	Do	Do.	Do.	Do.	Do.	Do.	XII ,,
37	Do.	2nd September 1921	30th September 1921	Do.	Do.	Do.	I ,,
38	Do.	Do.	Do.	Do.	Do.	Do.	II ,,
39	Do.	Do.	Do.	Do.	Do.	Do.	III ,,
40	Do.	Do.	Do.	Do.	Do.	Do.	IV ,,
41	Do.	Do.	Do.	Do.	Do.	Do.	V ,,
42	Do.	Do.	Do.	Do.	Do.	Do.	VI ,,
43	Do.	Do.	Do.	Do.	Do.	Do.	VII ,,
44	Do.	Do.	Do.	Do.	Do.	Do.	VIII ,,
45	Do.	Do.	Do.	Do.	Do.	Do.	IX ,,
46	Do.	Do.	Do.	Do.	Do.	Do.	X ,,
47	Do.	Do.	Do.	Do.	Do.	Do.	XI ,,
48	Do.	Do.	Do.	Do.	Do.	Do.	XII ,,
49	1,150 c. c.	7th December 1921	20th March 1922	Living	Attacked heavily.	Do.	Bazaar wheat.
50	Do.	Do.	Do.	27th	Do.	Living	Do.
51	Do.	Do.	24th January 1922	Do.	Do.	Do.	Montgomery type.
52	Do.	Do.	12th April 1922	Do.	Do.	Dead	Do.
53	Do.	not sealed	Do.	Do.	Do.	Living.	Bazaar wheat (control).
54	1,150 c. c.	19th April 1922	18th May 1922	Do.	Do.	Do.	Do.
55	Do.	Do.	23rd May 1922	Do.	Do.	Do.	Montgomery.
56	Do.	Do.	Do.	Do.	Do.	Dead	Bazaar wheat.
57	Do.	Do.	Do.	Do.	Do.	Do.	Do.

NOTE.—Nos. 50 and 51 have given unexpected results probably because the flasks were not properly sealed as they were not tested before being opened.

TABLE B.

The following table shows the results of experiments conducted in earthen buckets placed at room temperature :—

No.	Date of sealing.	Capacity of bucket.	Kind of wheat.	Date of opening.	Result.	REMARKS.
1	30th June 1921	4 seers	Heavily attacked	5th September 1921	Larvæ living	Mouth closed with mud
2	Do.	Do.	Do.	Do.	Do.	Paraffin coated.
3	Do.	Do.	Unattacked	4th August 1922	No sign of attack.	For $1\frac{1}{2}$ hours heated to 60° and closed with mud.
4	Not sealed	Do.	Attacked heavily	Already open	Living	Control.
5	5th September 1921	Do.	Do.	15th January 1923	Do.	Paraffin coated and closed.
6	19th July 1922	$4\frac{1}{2}$ seers	Do.	6th September 1921	Do.	Mouth closed with mud.
7	Do.	Do.	Do.	4th August 1922	Do.	Do.
8	Do.	Do.	Do.	18th July 1922	Do.	Do.
9	Do.	Do.	Do.	6th September 1922	Do.	Mouth closed with paraffin and mouth coated with wax.
10	Do.	Do.	Do.	11th November 1921	Do.	Do.
11	Do.	Do.	Do.	10th April 1922	Do.	Do.
12	Do.	Do.	Do.	13th June 1922	Do.	Do.
13	25th January 1922	5 seers	Do.	31st January 1923	Do.	Do.
14	Do.	Do.	Do.	Do.	Do.	Coated with coal Tar and mouth closed with paraffin.
15	Not sealed	Do.	Do.	Control	Do.	

TABLE C.

No.	Capacity of flask.	Approximate amount of wheat used.	No of larvæ.	Date of sealing.	Atmosphere.	Date of unsealing.	Result.	Result after 24 hours.
1	2,400 C.C .	$\frac{3}{8}$ seer.	Heavily attacked wheat.	29th July 1921 .	CO_2 by burning candle.	2nd August 1921	Larvæ motionless	Dead.
2	Do. .	Do. .	Do. . .	Do. . .	Air (control)	Do. . .	,, living .	Living.
3	Do. .	Do. .	Do. .	3rd August 1921 .	CO_2 (candle)	16th August 1921	,, motionless	Dead.
4	Do. .	Do. .	Do. . .	Do. . .	Air (control)	Do. . .	,, ,,	Do. *
5	Do. .	Do. .	100 larvæ .	20th August 1921	CO_2 (candle)	10th October 1921	,, ,,	Do.
6	Do. .	Do. .	Do. . .	Do. . .	Air (control)	Do. . .	,, living .	living.
7	Cylinder 860 C.C.	$\frac{1}{4}$ seer.	Heavily attacked wheat.	23rd May 1921 .	CO_2 (candle) .	30th May 1922 .	,, motionless	Dead.
8	Cylinder 390 C.C.	$\frac{1}{8}$,,	Do. . .	Do. . .	Air (control)	Do. . .	,, moving .	Living.
9	,, 860 C.C.	$\frac{1}{4}$,,	Do. . .	Do. . .	CO_2 (candle)	31st May 1922 .	,, motionless	Dead.
10	,, 390 C.C.	$\frac{1}{8}$,,	Do. . .	Do. . .	Air (control)	Do. . .	,, moving .	Living.
11	Kerosine tin	13 seers	Do. . .	13th June 1922 .	CO_2 (candle) .	24th June 1922 .	,, motionless	Dead.
12	Drum . .	15 ,,	Do. . .	Do. . .	Air (control)	Do. . .	,, moving .	Living.
13	Kerosine tin	13 ,,	Do. . .	28th August 1922	CO_2 (candle)	6th January 1923	,, motionless	Dead.

14	Drum ? .	15 ,,	Do. . .	Do. . .	Air (control)	Do. . .	50 per cent. moving 50 per cent. motionless.	50 per cent. living. 50 per cent. dead.
			In the following	Experiments CO_2	was obtained	from Kipps apparatus.		
15	Flask 600 C.C.	½ seer	10 larvæ . .	22nd July 1922 .	CO_2 . .	31st June 1922 .	Motionless . .	3 revived. 7 dead.
16	Do. . .	Do	Do. . .	1st August 1922 .	Do . .	4th August 1922 .	Do. . .	Dead.
17	Do. . .	Do. .	Do. . .	Do. . .	Do. . .	5th August 1922 .	Do. . .	Do.
18	Do. . .	Do. .	Do. . .	Do. . .	Do. . .	6th August 1922 .	Do. . .	Do.
19	Do. . .	Do. .	Do. . .	Do. . .	Do. . .	7th August 1922 .	Do. . .	Do.
20	Flask 50 CC.	¾ seer.	Wheat heavily attacked.	Not sealed . .	*Air . .	Open already .	Living . .	Living.
21	Do. . .	Do. .	Do. . .	25th August 1922	CO_2 . .	29th January 1923	Motionless . .	Dead.
22	Do. . .	Do. .	Do. . .	Do. . .	Do. . .	Do. . .	Do. . .	Do.
23	Do. . .	Do. .	Do. . .	Do. . .	Do. . .	Do. . .	Do. . .	Do.
24	Do. . .	¼ seer.	Do. . .	Do. . .	Do. . .	Do. . .	Do. . .	Do.
25	Do. . .	Do. .	Do. . .	Do. . .	Do. . .	Do. . .	Do. . .	Do.
26	Do. . .	Do. .	¾ seer . .	Do. . .	Do. .	Do. . .	Do. . .	Do.

* Cause not known.

TABLE D.

Table showing the percentage of germination of samples of wheat treated with CO_2 and Control for 5 months from 25th August 1922 to 24th January 1923.

Treated with CO_2		Control.		
Type of wheat.	Germination.	Type of wheat.	Germination.	
	(Percentage.)		(Percentage).	
1	100	1	100	
2	100	2	100	
3	100	3	94	3 grains were damaged.
4	100	4	100	
5	96	5	100	
6	100	6	100	
7	90	7	100	
8	100	8	92	4 grains were damaged.
9	100	9	100	
10	100	10	100	
11	96	11	100	
12	98	12	100	
13	92	13	100	
14	100	14	100	
15	100	15	100	
16	100	16	100	
17	100	17	100	
18	100	18	100	
19	100	19	100	
20	100	20	100	
21	100	21	100	
22	100	22	96	
23	100	23	100	
24	100	24	98	
25	100	25	100	
8A	100	8A	100	

I can confirm some of Mr. Husain's results. I tried the effect of exhausting oxygen by burning candles in jars. The earthen pots are porous and difficult to make airtight. We have tried white washing and smearing them with cow-dung but with no effect. It is difficult in India to obtain air-tight receptacles.

Grain stored in air-tight receptacles (that is to say, as airtight as is possible in actual practice, by the use of mud-sealed bins and so on) is often more heavily attacked than that left in the open. Mr. Robertson Brown described at our Third meeting a successful method of storing grain, employed at Peshawar. (Rept. Proc. Third Entom. Meeting

pp. 759-760) I saw the godown when at Taru and can confirm Mr. Robertson Brown's statement. The grain was heaped up on the open floor of a building of deodar. Grains stored in mud-rooms with the shutters closed and smeared with clay become badly infested with *Trogoderma khapra*. I ascribe the difference to the fact that in the well-ventilated deodar house the grain is exposed to greater variations of temperature which prevents heavy infection.

There is a considerable difference of opinion on this point. Some say that grain stored in well-ventilated godowns is more heavily attacked while others maintain that it is attacked in air-tight stores. Authorities also differ in opinion as to the efficacy of CO_2 as a check to stored grain pests.

Oats are stored in North Bihar in such a way that there is free access of air, and little or no damage is caused by insect attacks ; what little damage is done is on the top two or three inches only of the stored grain.

In the Punjab when the grain is stored in the bins the attacked grain is always around the mouth of the bin and the top-layer but there is no attack in the centre.

That is always the case.

34.—A PRELIMINARY ACCOUNT OF THE TACHARDIPHAGOUS NOCTUID MOTH *EUBLEMMA AMABILIS.*

By RAI BAHADUR C. S. MISRA, B. A., *First Assistant to the Imperial Entomologist.*

References to Eublemma amabilis, Moore.

MOORE. . . .	1884. Lepidoptera of Ceylon iii, p. 54 t. 150, fig 2.
HAMPSON . . .	1894. Fauna of India, Moths, Vol. II, p. 339
DUDGEON . . .	1901. Jour. Bom. Nat. His. Soc., Vol. XIII, p. 379.
LEFROY . . .	1909. Indian Insect life, p. 457.
HAMPSON . . .	1910. Catalogue Phalaenae Vol. X, p. 183.
C. S. MISRA. . .	1917. Proc. Second Ento. Meeting, Pusa, 1917, p. 249.
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I have already spoken in one of my papers (Lac culture in India ; *Proceedings Third Entomological Meeting, Pusa*, 1919, page 797) of the seriousness of this pest to lac cultivation and extension, and any one who has followed the ups and downs of the industry during the past eighteen years will have been struck with the part played by this destructive insect in the economy and development of the lac insect. There are areas within the important lac-cultivating zones where the pest is extremely bad, so much so that it would not be an exaggeration to say that 20 to 25 per cent. of the crop is damaged in each season within such tracts. As pointed out by me in the new edition of my Bulletin on Lac (*Bull. No. 142, Agri. Res. Ins., Pusa*, 1923, pp. 2-3), if the minimum loss of 5 per cent. of the total produce be taken, it will amount to no less a sum than thirty-seven lakhs of rupees. The reason why serious complaints are not so frequently heard as they should have been, is due to the ignorance of the cultivators regarding the presence of the pest and the havoc wrought by it in their plantations. In their opinion, whenever a crop fails, is poor, or much below their expectations, they ascribe this to climatic conditions, which, though one of the chief determining factors regarding

the poorness or otherwise of the crop, are not the only factors to be considered. That the predaceous moth is very destructive to the successful establishment of the lac insect whenever it is introduced to new localities for the first time has been mentioned by me in the revised edition of the Lac Bulletin. Last July, when I was deputed to examine and report on the possibilities of lac cultivation and extension in the Bankura district, Bengal, I was very much struck with the destructiveness of the moth in that tract. Two decades back, the tract referred to above was able to supply the raw material needed for the shellac factories at Sonamukhi and Khatra within the district. But in course of time the supplies fell off to such an extent, that at first the manufacturers had to go and obtain their supplies from the adjoining districts of Singbhum and Manbhum in the province of Bihar and Orissa. But, with the establishment of shellac factories within these two districts, their supplies were cut off and they had to fall back on imported Burma lac and when the consumption of this stuff increased in Calcutta, as well as other shellac manufacturing centres, they were compelled to close down their factories. On examining the factors that had contributed to the decadence of the industry within the district, it was found that this predaceous moth was a great deal responsible for the extinction of the industry. In some places within the district, so heavy was the infestation, that nothing was left on the trees excepting the webbings of the caterpillars. That this state of affairs was due to negligence, and to the malpractice of allowing a part of the crop to remain on the trees, was fully evident; such a large number of *Eublemma amabilis* was present within the locality that, as soon as cultivation was started in fresh localities, a few months after, it was clean wiped out. Such has also been my experience when I visited the lac cultivation experiments in the Raipur Division in the Central Provinces and Mr. C. M. Harlow, the special lac officer in the Central Provinces, also shared in my opinion. After doing lac work for two years on a fairly large scale, he too was of the opinion that in any scheme of lac cultivation and extension the possibilities of damage that was likely to be done by this predaceous moth were fully to be kept in view. He related to me a case where he had tried to grow lac for the first time from broodlac obtained from his own forest nurseries but before the crop was ripe it was clean wiped out by *Eublemma,* and he too shared the opinion, that more work was to be done in this connection than has been done in the past. A visit to the lac-growing experimental areas in the Dhamtari Sub-division of the Raipur Forest Division showed that, if any progress was to be made with the extension of lac cultivation and establishment of nurseries for the supply of healthy brood-lac to prospective growers, it was essential that

more should be known regarding the life history of the predaceous moth than has been done in the past with a view to adopt such measures as would circumvent the loss caused by the moth annually.

Sir George Hampson has listed 128 species of *Eublemma* (Catalogue of the Lepidoptera Phalaenae, Vol. X, pp. 63-193), of which 44 are recorded from India and Ceylon. The total number of *Eublemma* moths that have been recorded as coccidiphagous is 6 and out of these, three only have been recorded to feed on Coccidæ in India and Ceylon. The fourth one that is decidedly coccidiphagous is *Eublemma scitula :*

1. *Eublemma vinotincta*. .	*Lecanium* sp. Pundaluoya (Ceylon).
2. *Eublema coccidiphaga* .	Pipal lac ; (Sonapur Tea estate. Lac on Pipal, Pusa, 24-IX-1910. *Lecanium*, Puttalam (Ceylon), *Pulvinaria*
3. *Eublemma amabilis* . .	*Tachardia lacca* ; India, Sikkim, Ceylon and Singapore.
4. *Eublemma scitula* . .	*Anomalococcus indicus*, S. India (S.I. I., p. 381)

The species of Coccidæ in which individuals of this genus have been recorded by Sir George Hampson to feed are :—

Lecanium.
Pulvinaria.
Tachardia.
Anomalococcus.

Besides these, E. Meyrick has recorded *Pammene isocampta* Meyr. (Exotic Microlep, Vol. I, pp. 196-197 ; July 1914) as feeding on *Lecanium* sp. at Peradeniya (Ceylon).

Eublemma amabilis is very destructive to lac, and especially so where the cultivation of lac has been started for the first time. The moths which happen to be feeding on alternative hosts attack in large numbers the incrustation on the branches and leave nothing behind excepting thick silk webbings thickly interspersed with bits of resin. The lac collected from badly infested trees is very difficult to wash on account of its being mixed up with silken threads containing pellets of excreta. The moth has become so well established in certain lac-growing tracts that a considerable portion of the produce is annually destroyed, and as it has been present in such localities for a long time any preventive and remedial measures that are to be applied would take time to produce any tangible results. Besides, the adoption and proper fruition of measures is likely to be vitiated by the apathy of the people who do not readily wish to give up their antiquated methods of collection and storage. In the past,

the ravages of the pest have increased on account of defective methods of cultivation. The practice of inoculating half the tree, or leaving a portion of the crop on the tree to reproduce itself during the following season, has led to the breeding of an abnormally large number of predator moths which have laid heavy toll on the yearly produce in the past. This practice is resorted to to economise brood-lac, but I think it is a false economy, as it causes a greater loss in the long run than is generally supposed. An individual may be also able to save a few rupees by not entirely removing one season's crop from his tree, but by allowing a portion of his crop to remain on the trees to breed he gives greater chances for the predator moth to reproduce itself unmolested. Another reason why the recurring loss caused by the predator moth is not felt by the growers is that the *Eublemma* caterpillar works hidden, and the moth, being crepuscular, is rarely seen during the day. It is when the crop is scraped off the branches of trees that a large number of whitish insects are seen. These are either systematically picked out or allowed to wander about the floor with the result that, though a number are destroyed, yet the great majority of them hide themselves in the crevices, etc., in or near the scraping floor, pupate and come out as moths. The manufacturers too have unconsciously helped the increase of the pest. If they were to buy only clean, well desiccated lac, they would be to a great extent limiting the increase of the predator moth ; or if they were to persist in buying seed-lac, however imperfectly washed, they would be contributing materially towards reducing the number of predator moths in the area, and lessening the cost of washing the crude material. The cultivator, too, though put to some extra labour and cost, would be increasing the fertility of his soil, by putting the washed material on to his land. No doubt these practices are hard to abolish but, if full measure of success is to be derived from lac cultivation and shellac manufacture, it is essential that several malpractices that have crept into the trade should be eradicated, and it is high time now, considering the high value that lac fetches in the market, that a beginning be made to adopt such measures, and give up such other practices as have helped the increase of the obnoxious insect. This can only be done by concerted action on the part of the growers as well as of the manufacturers, and before any such action would bear tangible results, it is also essential that measures against the pest should be persisted in for some time.

The difficulty of adoption of successful measures is increased by the fact that the moth seems to have a number of alternative hosts and until these are studied in detail it will not be possible to adopt effective measures to yield results commensurate with the time and labour spent in

combating its ravages. Besides, in important areas of lac cultivation, some lac grows of itself on a number of trees within such area. The amount thus growing is at times so small that the cultivator does not care to collect it, with the result than the lac insect reproduces itself on such trees and the *Eublemma* moths too do the same, with the result that a sort of miniature insectary seems to exist in such areas where the breeding of the moth goes on uninterruptedly for a series of years, until, owing to unfavourable climatic conditions, the amount of volunteer lac appreciably decreases, with the consequent lessening of the predator. But it seldom totally disappears from such areas. With the lapse of time and return of favourable years the lac insects on trees again increase and the moth fully keeps pace with the increase of its host. It is on account of the extremely wide distribution of the lac insect in the lac-producing zones, that the difficulty of adopting efficient methods to check the pest are generally felt.

The moth is practically present in all centres of lac cultivation, but the meagre records of its distribution within the country show the necessity of more intensive collecting being done so as to enable one to see where it is most present, as at present one cannot form any opinion as to where the predator is most serious. Our records show that it is present in the following places :—

BIHAR AND ORISSA .	Pusa, Daltonganj, Gaya, Hazaribagh, Ranchi, Pakur, Chaibassa, Sambhalpur.
BENGAL. . . .	Bankura, Rangpur, Malda, Midnapur, and Murshidabad districts.
UNITED PROVINCES . .	Saharanpur, Rae Bareilly, Bareilly, Gonda, Bahraich, Lucknow district, Chakia, Benares State, Pilibhit.
CENTRAL PROVINCES .	Raipur, Bilaspur, Jubbulpur, Damoh, Narsingpur, Seoni, Chhindwara, Hoshangabad, Bhandara, Chanda and Balaghat districts, Chaorakund range, Melghat (Berar).
BOMBAY . . .	Nandurbar (W. Khandesh), Sindh.
MADRAS. . . .	Banganapalli, Ganjam, Bangalore, Coimbatore.
TRAVANCORE . .	Arambōly.
PUNJAB . . .	Una Tahsil (Hoshiarpur).
BURMA . . .	Maymyo (Upper Burma).
ASSAM . . .	Barpani estate, Palshbari.*
CEYLON. . . .	....
TONKIN . .	....

Sir George Hampson records it from the Punjab, Moghal Serai, Sikkim, Madras, Belgaum, Ceylon, and Singapore. But I am sure the moth has a far wider distribution than has been given above.

The moth lays greyish-white, flat round eggs depressed in the centre, with beautiful sculpturing of the chorion. The eggs are laid singly on the resinous cells of the lac insect. In case several moths have oviposited, a large number of eggs may be found together. As it matures, the egg turns pinkish-white, becoming greyish-pink prior to the emergence of the larva.

Description of the egg.

Each egg is 0·35 to 0·37 mm., broadly circular, depressed in centre, with longitudinal ridges radiating from the centre laterally, each such lateral ridge bearing small, circular flattened spots, the whole presenting a beautiful sculpturing of the chorion when seen under the microscope; colour greyish-brown. The egg, when fully matured, turns fuscous-pink with a dark black spot at the side; this black spot represents the black head and prothoracic shield of the developing embryo within the egg-shell.

The larva when about to come out of the egg-shell gnaws a hole at the side of the chorion and comes out. In examination of over 741 hatched eggs, the hole of exit was invariably found to be at the side. No egg-parasite has hitherto been bred out although a large number of eggs were kept.

All the eggs laid by a female do not mature at one and the same time. Some mature earlier than the others. The fully matured egg may be readily distinguished from others which have not reached an equal degree of maturity. The presence of a black spot at one side of the chorion wall is an index of the maturity of the egg. The wall of the chorion is so transparent that under a high power microscope the movements of the maturing embryo may easily be seen. The developing embryo lies curled up alongside the wall of the chorion; in fact, its mouth parts touch the anal end. It may also be seen to be moving its broad mandibles sideways to gnaw a hole at the side. In one case a larva was seen to have taken 22 hours to gnaw the hole of exit for itself at the side of the chorion wall. When the nymph comes out, it does not stop on or near the empty egg-shell, but moves on in search of its food. In one case, when eggs were laid by a moth, six days after its emergence, a larva that emerged 11 days after the eggs were laid in the bottom of a breeding cage, when taken out and placed on a Ber-stick containing male and female resinous cells, took five hours to enter one of the female lac resinous cells

from the side. It was further seen to have come out of its first gallery and to have begun gnawing at the side of another lac resinous cell.

Larva immediately after coming out of the egg-shell.

Length 0·51 to 0·54 mm., greatest breadth over the anterior part of the thorax 0·15 to 0·18 mm. Head broad and flat, shiny black with a few small whitish hairs on it, clypeus with labrum pale shiny black, frons triangular with the sides deep shiny black ; the posterior end of the vertex projects far down the pronotum and thus gives an appearance of the presence of a black pronotal shield ; prothorax broader than meso- and meta-thoraces ; abdominal segments distinct, dull white, with a few porrect small hairs on them dorsally as well as laterally. The presence of black fæcal matter in the hind gut shows as a blackish spot in the segment. The broad black head with prominent black jaws is very characteristic of the caterpillars of the first stage. Though slow in their movements, they seem to be very hardy and were seen to make their way easily amongst lac female resinous cells heavily covered with cretaceous white waxy threads.

Pupa (winter season); taken out of the gallery ; dorsal view. Length 7·5 to 8 mm., breadth 2 mm. Colour dark brick-brown excepting a pair of eyes, the lateral edges of antennae and posterior and the anal end, which are dark castaneous. Head deflexed, hidden under the prothorax which is pointed in the middle, anteriorly with a dorso-longitudinal carination extending from the middle of prothorax to the middle of mesothorax dorso-posteriorly, it is insinuate in the middle at posterior margins. This dorso-longitudinal ridge is very prominent. Mesothorax is the longest, sharply sinuated in the middle posteriorly, its extreme lateral apex reaching the middle of the fourth abdominal segment laterally. Metathorax about half as long as the prothorax, broad, angularly sinuate posteriorly, its extreme lateral apex reaching the middle of the third abdominal segment laterally. Nine abdominal segments distinct, the anal segment with two stout dark castaneous spines.

The young larva on emergence moves about seeking entrance within the resinous cell. It moves down and begins to bite off small pieces of resin from the lac cell until it is able to effect an entrance ; when once it is within, it hardly comes out, unless it has got no more food left on the branch. It then may be seen moving about, but this is rather rare. The presence of minute bits of pale-yellow translucent resin, as well as pieces of tissue bitten off from the body of its victim at the mouth of the hole, is sufficiently indicative of the presence of the predaceous

caterpillars. But such holes of entrance are so small that they are not seen easily with the naked eye. If, however, they are examined at close quarters with a hand magnifier, their position is easily located. The caterpillar goes on devouring the males as well as females and making galleries for its passage within the resinous encrustation. Such galleries are lined with a thin silken web. The passage is also filled with somewhat oval flat deep crimson-coloured excretal discs, not infrequently containing a large proportion of resin. It kills more females, which produce the majority of commercial lac, than it actually devours and as such does more harm than is supposed to be the case. A large number of females are devoured, but a greater number have their bodies torn off, penetrated or otherwise mutilated during the progress of the larva. In Northern India these larvæ are found in company with the larvæ of *Holcocera pulverea*, whilst in Southern India, especially at Bangalore, it occurs along with the larvæ of *Anatrachyntis falcatella* (*Proceedings Fourth Entomological Meeting*, 1921, pp. 250-251). When full-fed, it makes a circular opening on the resinous encrustation, lines it with a whitish material of silken texture and retires to pupate or æstivate according to the time of the year. The adult moth comes out by making an opening in the free end of the gallery and comes out. It is then cretaceous white and is very slow in its movements. It is to be seen resting on or near the resinous encrustation during the day. It becomes active at dusk. In one of the rearings of the egg to the adult stage it was suspected that agamogenesis possibly prevails in this species; with a view to elucidate this point further rearings are being made and the result will be communicated hereafter.

There are from two to three broods during the year but these broods overlap, with the result that moths are present in numbers from March to December. The caterpillar æstivates during the winter but with the advent of hot days it pupates and the adult moths come out. During the middle of December last year (1922), when the minimum of 45·8 was touched after a fall of 0·38 rain two days before, a number of moths emerged in the breeding cages, at Pusa. These laid eggs by the end of December 1922, and these have not hatched as yet (9th February 1923). There is a considerable range of variation in colour of the wings of the adults. The male is smaller than the female which has a robust abdomen. The moths are not attracted to light.

We have bred *E. amabilis* from *Tachardia* spp., whilst *Eublemma scitula* has been bred from *Ceroplastes* sp. on *Melia azadirachta*, and *Eublemma* sp. (near *quadrilineata*) from *Phenacoccus hirsutus*, and *Pseudococcus filamentosus* var. *corymbatus* was infested with *Eublemma* caterpillars but through an accident no adults were reared out.

Attempts are now made to rear *Eublemma* moths from other Coccidæ besides *Tachardia* spp.

1. *Ceroplastes actiniformis.*
2. *Ceroplastes* sp. on *Melia azadirachta.*
3. *Lecanium* spp.
4. *Pulvinaria.*
5. *Phenacoccus.*
6. *Pseudococcus.*
7. *Cerococcus.*
8. *Antonina.*

Eumblema amabilis is also being reared to mark the amount of parasitisation from lac on the following food plants :—

1. *Zizyphus jujuba.*
2. *Zizyphus xylopyra.*
3. *Butea frondosa.*
4. *Butea superba.*
5. *Polyalthea longifolia.*
6. *Nephelium litchi.*
7. *Ficus religiosa.*
8. *Albizzia lebbek.*
9. *Rosa spp.*
10. *Acacia arabica.*
11. *Shorea talura.*
12. *Pithecolobium saman.*

Predators and Parasites. Hitherto no effective predator or parasite has been found to keep the moth in check. The peculiar habits of the predaceous larvæ render them wholly or partially immune to the attack of the parasites and other predators. Immediately after hatching, the predaceous caterpillar remains hidden in silken galleries within resinous encrustations and externally there is no sign of the presence of caterpillars within the resinous mass of cells congregated on stems of the food-plants excepting the holes of exit of the adult moths (see figure 6, page 27, *Bulletin No. 142*) and it is no wonder that this should be so. The predaceous larva, seldom if ever, comes out of its gallery and as such is not exposed to the attacks of predators and parasites.

We have however been able to rear two parasites :—The grub of a Braconid parasite is found on the *Eublemma* caterpillars. It is a whitish legless grub, pointed at one end and broad at the other. It has a pair of pointed chitinous dark brown mandibles. The adult more or less superficially looks like a *Microbracon*. The other is a small black Chalcidid

occasionally found parasitizing the *Eublemma* caterpillar in their galleries. At one time we reared a number of Braconidæ, especially *Microbracon* spp., from other hosts than the lac insect.

These were reared from :—

1. *Platyedra gossypiella.*
2. *Epicephala chalybacma.*
3. *Eublemma quadrilineata.*
4. *Adisura atkinsoni.*
5. *Alcides leopardus.*
6. *Carpomyia vesuviana.*
7. *Sylepta derogata.*
8. *Phycita infusella.*
9. *Anarsia melanoplecta.*
10. *Chlumetia transversa ;*

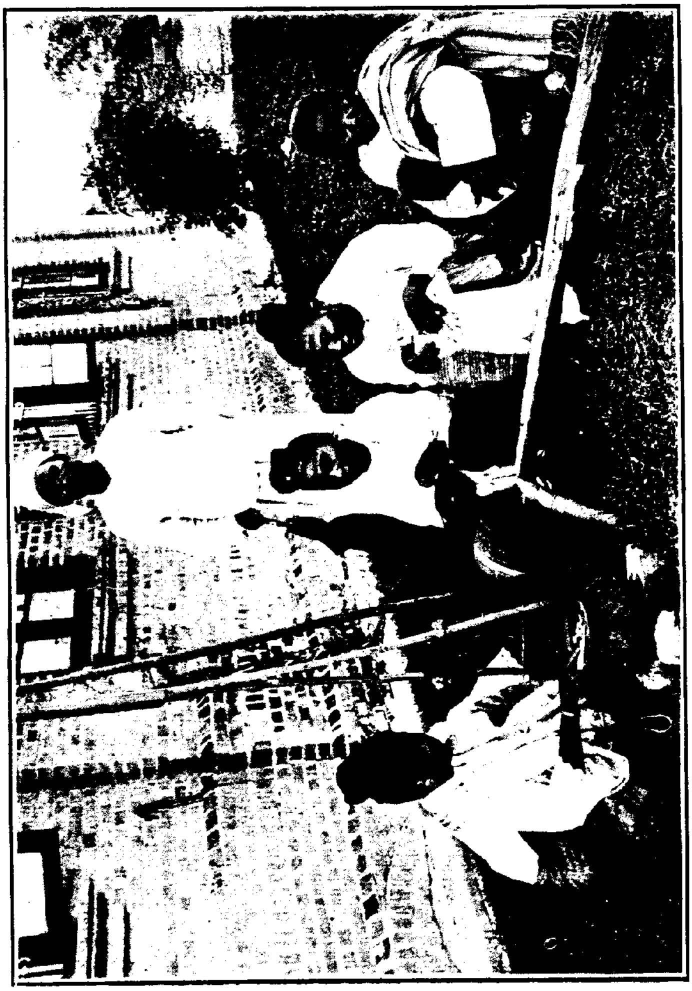
but unfortunately, through enemy action during the year 1917, when they were sent out for identification, they were lost in transit.

35.—A NOTE ON SERICULTURE IN BURMA.

By C. C. Ghosh, B.A., F.E.S., *Assistant Entomologist, Burma.*

(Plate 17.)

The history of sericulture in Burma, although never a very extensive industry compared with that in India, but still not an unimportant one, has been of late one of continued decadence. As recently as only about ten to fifteen years ago many districts recorded at least a group of silk-worm rearers where no trace of them is left at the present time. The industry is said to have originally started with the prisoners brought from Assam and spread among Burmans, Yabeins, Karens, Kachins and others. It was never and probably never will be taken up by orthodox Buddhists. No scientific attempts were ever made to help it and therefore, being left to itself in the hands of "amateurs," it has not been able to stand the competition with imported silk and has been dwindling away and would have completely disappeared but for the very high price for silk prevailing in the after-war years. At present the only districts where it may properly be said to survive are Prome and Toungoo and it is carried on by Yabeins and Karens living in the hilly regions. The methods, however, are very defective. Mulberry is started much in the bush system with one or two cuttings at one place. The plants grow one or two at a place at distances of about one-and-a-half to two feet each way. They are never pruned, the plucking of leaves being commenced soon after they grow. As a result they cease to bear sufficient and good leaves after about three years, when they are cut down and made into cuttings which are put down elsewhere, the old plantation being abandoned. The mulberry is grown in this manner mainly on the banks or silted beds of hill and forest streams and rarely on the hill-sides. The supply of leaves therefore is never very large and each leaf has to be plucked from the plants. This is a bar to any rearing on a large scale. The rearers keep their own seed. The method is to confine twelve female moths after fertilization on a piece of paper inside a circle of palm-leaf, the eggs being heaped inside this circle. Such an egg-card sells for two annas each. Great care is, however, taken in feeding the worms. On account of the prevalence of the fly pest the trays are kept covered with a piece of cloth, a bamboo bow being placed under the cloth to keep it raised above the worms. The spinning tray in use among the Yabeins in Prome is an ingenious one. A specially made bamboo tape about two inches wide



Reeling machine in use amongst the Yabeins of Prome.

and a hundred feet long is arranged on its edge spirally on an ordinary tray, the worms spinning between the coils. When not in use the tape is rolled up and put away. Among the Karens in Toungoo it is crude, a number of bamboo rings, each made by giving two turns to a thin piece, being arranged on a flat mat and the worms made to spin among them. Reeling is of the primitive kind. The machine in use among the Yabeins in Prome is shown in Plate 17. The cocoons are placed in the hot water filling the earthen pot set over fire. Just above the pot there is a flat horizontal piece of bamboo with a hole in the middle. Above this there is a bamboo pulley. Both are fixed to two vertical bamboo pieces standing on the edge of the pot. The thread passes through the hole in the first piece and round the pulley to the block of wood which is turned with the left hand and around which it is wound. The reeling consists in pulling out with force a thick strand of thread, the cocoons being prevented from being drawn up by pressing them with a pair of iron tongs held in the right hand. Among the Karens in Toungoo district the round block is not used but the thread is pulled with the left hand and placed on a tray. The reeling is slow and the thread produced is necessarily coarse, thick and uneven, but it is however in great demand locally for making the commonly used thick *longyis*, bags, coats, etc. Reeling is done by the rearers themselves, being commenced about the third day after spinning and completed before the moths cut out.

It will be apparent that this is not real reeling, which consists in winding off the loosened filaments without force and without breakage. The flimsy cocoons spun by the local races of worms are reeled off wholly in this method, including the fluffy external layers. Better types of cocoons, even the Bengal Nistary or Mysore cocoons, can hardly be reeled.

The rearers live on raised huts built on pillars and wholly made of bamboo including the floor. Among the Yabeins the huts have usually three walls, one side being open. Among the Karens they are closed on all sides. The same hut serves all purposes, *viz.*, as cooking-room, sitting-room, bed-room and rearing as well as reeling room. Below the huts, cattle, pigs, etc., are stalled. The rearing trays are kept in tiers on bamboo shelves in one corner. Reeling is done over the fires kept in the huts over a layer of earth on a large movable tray. Under these conditions, production is small, the great majority of the rearers turning out about $1\frac{1}{2}$ to $3\frac{1}{2}$ lbs. of thread in the course of the year. Rearing is carried on during the rains and early winter among the Yabeins and only during early winter among the Karens. Pebrine plays havoc among the worms and of late years has been the principal cause of decline, many rearers giving up the work owing to " bad luck " as they said.

While this is the condition of production, consumption is very high. In fact no other province consumes as much silk as Burma, silken *longyis*, coats and *powas* (used as turban by men and a loose sheet round the neck by women) being articles of daily use among the majority of the men, women and children. Weaving of these articles is carried on on a large scale and is therefore important. The yarn is practically wholly imported, mainly from China and also from Siam and Japan. The cloth for *longyis* and coats is woven very thick, the yarn used being of about 50 deniers. The majority of the yarn comes in a doubled and twisted condit on and can be dyed and used in the loom with the least trouble. Therefore it is in high favour among the weavers who by nature are averse to taking much trouble in any of their work. Inferior yarn is also largely imported from Siam and is first of all unwound and sorted out into different grades according to thickness. This work is done on contract by many women and is wrongly described in reports as "spinning."

The immediate problems of sericulture in Burma are :—

(1) Introduction of the proper and improved method of growing mulberry and extension of mulberry area.

(2) Supply of disease-free seed. This will arrest the decline and increase production. When production of cocoons sufficiently increases (which cannot be expected before several years) it will be time to think of

(3) Organization of reeling on a factory basis, and

(4) Introduction of better races of worms producing superior cocoons, including univoltine races.

A trained man was placed for some time among the Yabein rearers in Prome district to demonstrate proper methods of growing mulberry to the rearers in a group of villages under the headman of Taungle. Supply of disease-free eggs to this group of villages was commenced last year from the Maymyo nursery started about a year and a half ago. The results have been thoroughly satisfactory as will appear from the fact that in the course of the last two years in this group of villages alone the number of rearers has increased from 15 to 55 and the mulberry from about 10 to 50 acres. The progress has been rapid as no plantations are now abandoned. Some of the rearers in this group of villages were encouraged to produce industrial seed which spread to other villages and even to the Toungoo district. It is now proposed to establish a nursery among the rearers themselves, mainly for rearing industrial seed on a large scale. For the Toungoo Hills two probationers

are undergoing training and they will be established among the rearers to rear industrial seed.

A reeler is engaged in the Maymyo nursery to teach reeling to the probationers on a simple Bengal type of machine which is proposed to be introduced among the Karens.

Various races of worms are being tried in the nursery. Four mongrel races seem to be promising. French univoltine races are being tried this year. Eggs are being hibernated in ice factories at Rangoon and Calcutta, in the cold stores of the King Institute at Guindy, Madras, and under natural conditions at Sinlumkaba in Bhamo district and at Keng-tung in Southern Shan States. As soon as the initial difficulties of hibernation can be overcome it is proposed to try these races among the rearers who, unlike the Bengal rearers, are ready to accept eggs.

Apart from the above under the Agricultural Department, there is a silkworm rearing farm at Lashio where men from different Shan States are trained. It is financed by the Shan States. Suitable tracts where sericulture can be carried on are existing all over the Province, especially in the hilly regions. Thinness of population is no doubt a drawback but still the possibilities of development under the existing conditions are very great. If mulberry trees can be got grown through some agency, and they will not take more than about eight years to come to the stage to bear plucking, sericulture can be placed on a permament footing on the same lines as in Kashmir.

36.—SHORT NOTE ON THE LIFE-HISTORY OF THE MANGO-HOPPERS (*IDIOCERUS SPP.*) IN THE PUNJAB.

By M. AFZAL HUSAIN, M.Sc., *Government Entomologist, Punjab, and* HEM SINGH PRUTHI, *Offg. Assistant Professor of Entomology, Lyallpur Agricultural College.*

INTRODUCTION.

Idiocerus atkinsoni, Leth., and *I. clypealis*, Leth., are very serious pests of mangoes, not only in the Punjab but in all the mango-growing tracts of India. The damage done to the flowers may be as much as 95 per cent. and not unusually orchards of hundreds of trees do not bear fruit sufficient even to pay the revenue. The annual loss which these pests are causing to the country is enormous, as in some Provinces, such as Bihar, the United Provinces, the Punjab and Southern India, a very fair portion of the total area cultivated is under this fruit. In 1883, when the prices were very low, the single district of Hoshiarpur used to produce mangoes worth about 3 lakhs (*Montgomery Settlement Report, 1883*). In many localities orchards which used to bring in thousands to their owners are now being cut down as unproductive or rather expensive. All this is on account of these bugs.

An account of the habits of these insects and remedial measures against them was communicated to the last Entomological Meeting (*Proceedings of the Fourth Entomological Meeting*, pp. 148-152). In the present paper are embodied observations on the life-history of these Jassids.

We experienced considerable difficulty in rearing mango-hoppers under laboratory conditions. These insects, for some reason or another not yet known, do not stand captivity well. In an ordinary pill box the adults do not survive for more than a few hours, and even when enclosed in a wire gauze cage many of them die within 24 hours. When adults are so susceptible to artificial conditions, it is not at all surprising that the delicate nymphs should be still more so.

After many trials the following method was found satisfactory :—Small crucibles with perforated lids were selected. Each crucible was filled with water and into this dipped the end of a branch of inflorescence, which was passed through the hole in the lid. Thus the twig was kept fresh for some time. It might be mentioned that, on account of rise in temperature, the mango twigs dried up very quickly. To

guard against the nymphs quitting the branch of inflorescence, a thick thread was wound round the base of the twig, and one end of this thread dipped in the water in the crucible to keep the thread wet. The wet thread made quite an effective barrier against these nymphs. If the thread happened to get dry, the nymphs were usually found to have deserted the twig. Frequent changes of food were also essential, because mango twigs even when kept in water do not live very long and the food, when much diluted, does not do very well for the nymphs. Side by side with work in the laboratory, observations in the fields were recorded. A number of young nymphs were sleeved on the trees and their development carefully watched.

Life-History.

Of the two species of mango-hopper found in the Punjab, *I. atkinsoni* and *I. clypealis*, the former is more common. Both these insects, as is well known, pass the major portion of the year in the adult stage. During the warmer part of the year *I. atkinsoni* clusters on the under side of the basal, thicker branches of the tree and of these they prefer those which are horizontal, while *I. clypealis* remains on the leaves. On the approach of winter they conceal themselves in the crevices of the bark and remain there till February, when the rising temperature makes them more active and both males and females migrate to the budding inflorescences which appear at this time, particularly towards the sides of the trees more exposed to the sun. The females begin to lay eggs about the middle of February and continue till about the middle of March. After fertilizing, the males die off. Thus, on the 25th February 1922, out of 60 individuals caught, there were only 4 males, while at the end of the month, no male could be seen in spite of hard search. The end of the females comes after oviposition. It may be mentioned that *I. clypealis* begins breeding a little later than *I. atkinsoni*.

Eggs.

The eggs are smooth, dull white in colour, ·05 mm. in diameter (*I. atkinsoni*). They are pointed at one end (the posterior end of the future embryo) and blunt at the other.

Seat of oviposition.

Eggs are laid most often in the tissue of the rachis of the inflorescence or in the tissues of the unopened flowers. They are partly embedded inside the tissues, their blunt tips only being visible. However, the

places where the eggs have been laid can be easily recognised by the dark brown colour of the surrounding tissues.

Number of eggs.

As mentioned above, the adults do not live long in captivity; consequently it has not been possible to study copulation and individually get females fertilized in the laboratory. In order to determine the number of eggs laid, several females caught from the mango trees were sleeved individually on uninfested inflorescence, on the 25th of February at Lahore, and on the 6th March at Lyallpur. In two cases only were males introduced along with the females, but it was found that all the females were fertilized, as they laid many eggs from which nymphs were obtained.

The results are given in the following statement. In case of *I. atkinsoni* (the larger of the two species) not more than 28 individuals were obtained from one female, while *I. clypealis* gave 101 to 190 young ones. This great difference in the number of progeny in the two allied species may be due to one of the two causes :—

(*a*) Either that *I. atkinsoni* does not breed freely in captivity,

or (*b*) the females might have laid some eggs before they were captured. The latter seems to be the more feasible explanation as *I. atkinsoni* begins breeding earlier than *I. clypealis*.

No.	Locality.	Species.	Female alone or with male.	Dates.
1	Lahore .	*I. clypealis* .	Female only .	24th Feb. to 31st Mar. 1922; 101 V stage.
2	Do. .	Do. .	Do. .	Do. do. 120 do.
3	Lyallpur .	Do. .	With male .	6th Mar. to 7th April 1922; 180 Adults, 4 V stage.
4	Do. .	Do. .	Without male .	6th Mar. to 7th April 1922; 191 V stage.
5	Do. .	Do. .	Do. .	Do. do. *Nil* V stage.
6	Lahore .	*I. atkinsoni* .	Do. .	24th Feb. to 31st Mar. 1922; *Nil* V stage.
7	Do. .	Do. .	Do. .	Do. do. 24 do.
8	Do. .	Do. .	With male .	Do. do. 26 do.
9	Do. .	Do. .	2 females .	Do. do. 45 do.
10	Do. .	Do. .	Without male .	Do. do. 28 do.

Number of generations in a year.

There is only one brood in a year. The females lay eggs in February and March, the young ones become adult in about 20 days, pass the whole summer and winter in this state, and breed next spring.

To determine this, a definite number of well advanced nymphs were sleeved on 21 inflorescences both at Lahore and Lyallpur, and in no case did these nymphs, after becoming adults, reproduce in the same season. We took special care to enclose a sufficiently large number of nymphs in each sleeve so that some of them were sure to be males and some females.

Duration of egg-stage.

The eggs hatch out after from 8 to 10 days ; to observe this, they should not be taken out of the shoot in which they are laid, as they shrivel up very soon.

Different stages in the life-history.

The nymphs undergo five moults, in a period of 18 to 20 days, and then become adults. Moulting takes place by means of a median longitudinal splitting in the region of the head and the thorax.

The delicate nymphs suck the sap from the various parts of the inflorescences, rachis, flower stalk, and even flowers. The nymphs of almost all the stages occur together, congregating on the inflorescence. They secrete a semi-liquid sticky substance called 'Honey Dew,' which falls on the flowers and leaves and gives a characteristic shining appearance to the latter. Due to the secretion of this 'oily' looking substance the pest is called *Tela* (from *Tel*, Oil), by *zamindars Chaipa* or *Chapak* (being sticky). They at once associate the 'oily' and shining appearance of the leaves with the attack of the pest and subsequent failure of the crop. The flowers, becoming weak by being deprived of their sap, wither or become too weak and the fruits, if they set, fall off.

The life-cycle and the time passed in the different stages by both the species is practically the same. The nymphs of the two species can easily be distinguished from each other. The nymphs of *I. atkinsoni* are elongated, more active and pale yellow in colour, whilst those of *I. clypealis* are comparatively broader, lazy and dull deep yellow in colour.

In the following account *I. atkinsoni* is chosen for description.

Nymph, first instar. A freshly-hatched nymph is a very delicate creature with a relatively large head produced in front of the eyes. The red compound eyes are very conspicuous. The three segments of the thorax are not markedly separated from each other. The abdomen is relatively small and tapers towards the posterior end. It is set with numerous black and long bristles especially arising from the posterior margin of the abdominal segment. The colour of the nymph

is pale yellow. Proboscis reaches beyond the metasternum. Tarsi are two-segmented. After one day the nymph elongates, becomes greyish in colour. The lateral region of the terga of the abdomen becomes especially black, the ventral surface remaining pale. The head does not protrude so much in front of the eyes, as was the case in the freshly hatched nymph. The thoracic segments begin to be distinct from each other. Legs remain transparent. Duration of life during the first instar is from 4 to 5 days.

Nymph, second instar. Just after the first moult the nymph is of a beautiful yellow colour, but within 24 hours it turns greyish-yellow. Eyes are red as usual. The individual is very active. The three thoracic segments are quite distinct from each other, meso-thorax being the widest of the three. The thorax as a whole is separated from the abdomen by means of a constriction. There are so far no rudiments of wings. The lateral region of the head, thorax and abdomen are very dark as compared with the median longitudinal area. Ventral surface is pale. The antennæ are also darker than during the first instar. The proboscis and legs are dirty white. The tarsi are still two-jointed. Bristles on the abdomen are reduced in number. Ten segments of the abdomen are clear, the first and the second being comparatively insignificant. Duration of life during the second instar is 3 days.

Nymph, third instar. The body is proportionately broader than in the second instar. The general colour is yellow, while the ventral surface is pale. Towards the end of this stage, the lateral regions of the body turn darker. Eyes dark red. Two black spots are recognisable on the vertex. The pronotum tends to overlap the head. The antennæ pale. On the thorax the rudiments of the future two pairs of wings appear in the form of blunt projections of the lateral posterior angles of the mesonotum and metanotum; they are almost equal in length. There is no differentiation of the meso-scutellum as yet. On the metanotum two black spots make their appearance. Abdominal segments are quite distinct. The lateral parts of the ninth segment turn black. Duration of life during the third instar is 3 days.

Nymph, fourth instar. On the second or the third day in this stage, the nymph elongates very much and becomes very active. The wing-pads are quite distinct. The nymph can leap from place to place by a characteristic movement of its abdomen which is very flexible. The general colour is dull yellow. The compound eyes are dark red. The black spots of the vertex and metanotum, and the ninth abdominal segment become very prominent. Pronotum also shows slight dark patches in places. The prothorax is distinct from the remaining segments. The meso-scutellum is distinct from its adjacent parts and can be recog-

nized by means of its dark lateral margins. The abdomen is very much elongated. The male and the female nymphs can be distinguished from each other at this time. Duration of life during fourth instar is about 3 or 4 days.

Nymph, fifth instar. At this stage a nymph differs from an adult simply in the size of the wings. Just after the fourth moult it is pale yellow, but it then rapidly goes on turning at first light grey, and then dark grey. The two spots on the vertex and the areas on the metanotum and the ninth abdominal segment are distinctly black, and there are also distinct dark patches on the pronotum, vertex and face. The meso-scutellum is quite prominent. The dorsum of the abdomen is dark, except the intersegmental areas. The ventral surface of the body is pale. The wing pads become very large. Duration of life in the fifth instar is 4 to 5 days.

Statement of measurements (in millimetres) of the various organs, in the different stages in life-history.

STAGES.	HEAD.					THORAX.				ABDOMEN.	
—	Breadth.	Distance between the compound eyes.	Length of antenna.	Length of proboscis.	Length of the head.	Length of one wing.	Length of 2nd wing.	Length leg III.	Length of thorax.	Length of abdomen.	Total length.
Freshly hatched nymphs	·3	·16	·26	·20	·28	..	..	·5	·11	·3	·7
1st instar	·4	.32	·31	·25	·25	..	..	·1	·3	·48	1
2nd „	·6	·4	·53	·26	·29	..	..	1·2	·5	·6	1·4
3rd „	·75	·42	·6	·35	·31	·3	·27	1·4	·68	1·2	2·19
4th „	1	·68	·75	·5	·34	·88	·46	1·75	·83	1·5	2·65
5th „	1·35	·83	1	·68	·35	1·25	·75	2·58	1	2·0	3·35

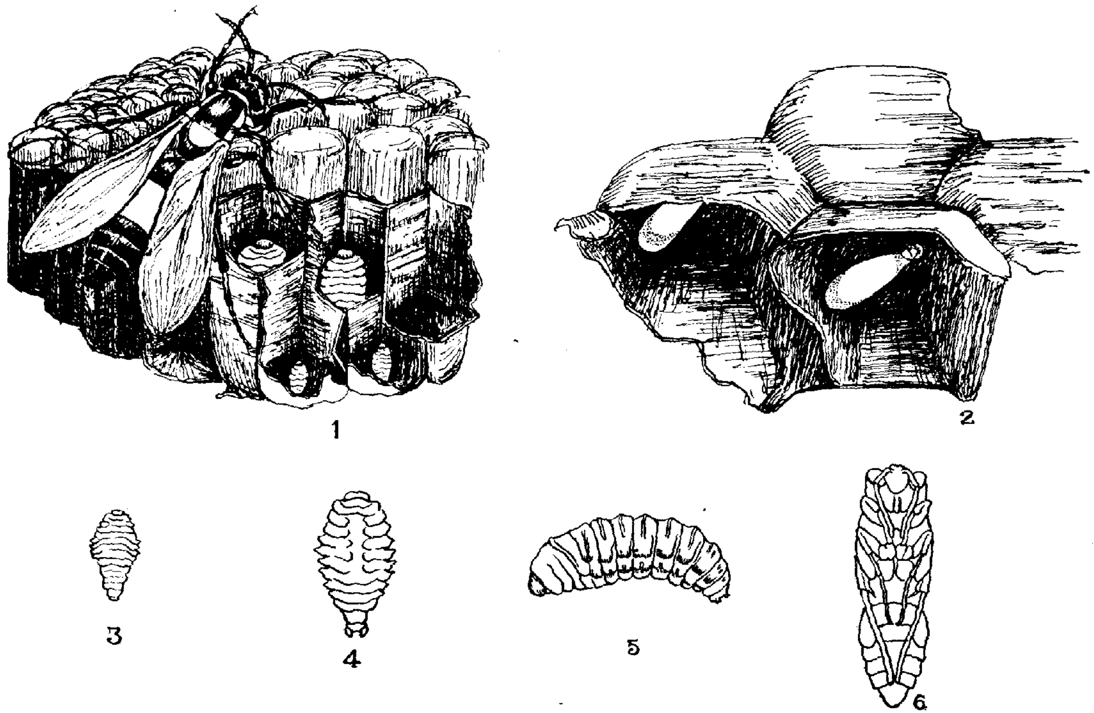
Statement of duration of different stages in life history.

No.	Species.	1st Instar.		2nd Instar.		3rd Instar.		4th Instar.		5th Instar.		Total No. of days.	Remarks.
		Dates.	No. of days.	Dates.	No. of days.	Dates.	No. of days.	Dates.	No. of days.	Dates.	No. of days.		
1	*I. atkinsoni* .	19th to 24th Mar.	5	24th to 27th.	3	27th to 29th.	2	29th to 1st.	3	1st to 5th.	4	17 days.	
2	*I. atkinsoni* .	3rd to 7th.	4	7th to 11th.	4	11th to 14th.	3	14th to 17th.	3	17th to 21st.	4	18 days.	
3	*I. atkinsoni* .	19th to 24th.	5	24th to 27th.	3	27th to 30th.	3	30th to 2nd.	3	2nd to 6th.	4	18 days.	
4	*I. atkinsoni* .	15th to 20th.	5	Died.									
5	*I. atkinsoni* .	21st to 25th Mar.	4	25th to 27th.	3	27th to 31st.	4	31st to 3rd.	3	3rd to 8th.	5	19 days.	
6	*I. atkinsoni* .	22nd to 26th.	4	26th to 29th.	3	29th to 1st.	3	Died.					
7	*I. clypealis* .	15th to 19th.	4	19th to 22nd.	3	22nd to 25th.	3	25th to 27th	4	27th to 2nd.	4	18 days.	
8	*I. clypealis* .	..	..	..	..	.	..	..	..	24th to 29th.	5	..	Caught in the 4th stage.
9	Two specimens.												
	I. clypealis .	..	..	..	..	..	..	..	..	2nd to 7th.	5	..	Do.
10	Five specimens.												
	I. clypealis .	..	..	..	..	..	..	..	..	3rd to 8th.	5	..	Do.

I worked out the life history of all the three species eight years ago but the results were not published as I hoped to discover a better remedy than spraying, but I have not succeeded so far. In the Punjab there appears to be only one time of multiplication but in Mysore there is a flush of mango leaves in July or October, of which *I. atkinsoni* and *I. niveosparsus* take advantage and start reproducing. *I. clypealis*, which breeds mainly on the flower spikes, is of course not affected. As regards attracting these insects, I tried coloured lights but found this to be of no use. I also tried a resinous extract from mango blossoms which had the smell of the flowers but did not succeed. The attacks of species of *Idiocerus* alternate in predominence. This may be associated with the fact that good and bad flowering years of mangoes also frequently alternate. Factors which appear to affect this alternation of attack are first the fact that *I. clypealis* breeds principally on flower spikes; secondly that the nymphs of the three species differ considerably in their power to withstand various temperature and climatic conditions; thirdly that they are attacked by parasites.

Idiocerus gives very little trouble at Pusa; attacks of a parasitic fungus have been observed which may be a controlling factor. Spraying is an economical possibility if the crop is very valuable as in the case of crops situated near very big towns.

With regard to winter spraying the trouble is, a large number of hoppers may not be on the mango trees at the time. I have noted all the three species on all sorts of trees and bushes near and far from mango trees and apparently they do not return until the buds are put forth by their host plants.



Vespa cincta.

1, part of a nest showing a wasp and cells containing pupæ and larvæ, $\times 1\frac{1}{3}$; 2, cells with eggs, $\times 4$; 3-5, larva in different stages, $\times 1\frac{1}{3}$; 6, pupa, $\times 1\frac{1}{3}$.

37.—LIFE-HISTORY NOTES ON *VESPA CINCTA*.

By T. V. Ramakrishna Ayyar, B.A., F.E.S., F.Z.S., *Assistant Entomologist, Madras.*

(Plate 18.)

The commonest forms of the hornet genus *Vespa* in the Plains of India appear to be *V. orientalis* and *V. cincta*. Bingham in his *Fauna* volume records the former only from North India and with regard to *cincta* he says it is common all over India. Lefroy in his *Indian Insect Life* records that *orientalis* is the commonest of the species in India. Though this may perhaps be the case in North India, quite the reverse is the case in Southern India. In fact, *V. orientalis* is extremely rare and I think I may not be wrong even when I state that the distribution of *orientalis* does not extend southwards further than Central India. I had recently an opportunity of looking at the Insect collections at Pusa and my view was confirmed in that I found not a single specimen of *V. orientalis* from Southern India and of *V. cincta* I found only very few from North India. Apparently *V. orientalis* is the commonest species in Northern India and *V. cincta* the commonest in Southern India, with the difference that while *cincta* goes further North, *orientalis* has not, so far as I know, been recorded from South India.

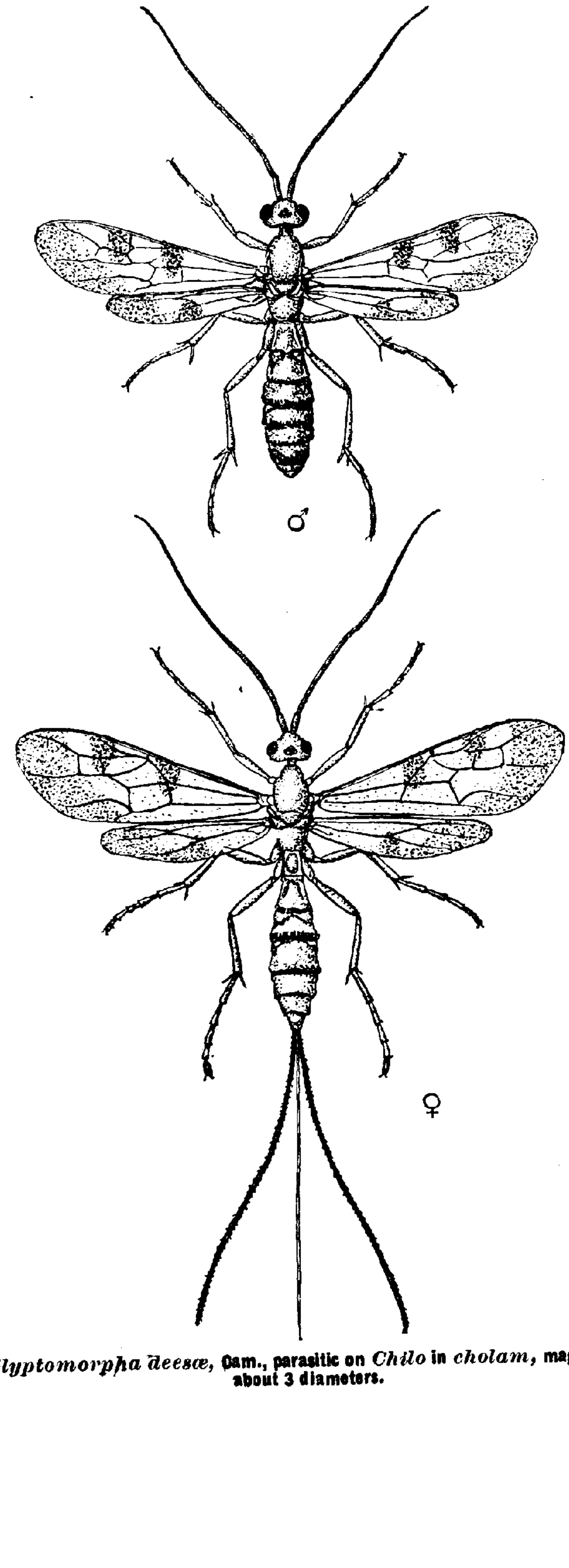
Though the general characters of these hornets are pretty well known as social wasps building their paper nests generally on forest trees and being predatory in their food habits, as noted by Cunningham, Gravely, Dover, etc., very little is on record regarding their early stages. This is probably due to the fact that these creatures are dangerous to meddle with because of their ferocious stinging habits when disturbed. The writer had some opportunity of studying a little about the developmental stages in a colony of *V. cincta* and the following are some of the necessarily imperfect notes on the same.

Each nest is made up of a number of circular combs attached one over the other like inverted umbrellas and each of these circular combs contains numerous hexagonal cells inhabited by the different stages of the insect.

All the different stages of the wasp are found at the same time in every colony—eggs, larvae, pupae and adults. The eggs are generally laid in the outer circle of cells which are the latest cells built.

The egg is bluish-white and smooth and attached to the cell wall by its proximal narrow end; it measures 3·5 mm. in length. By the time the egg hatches a fresh circle or two of new cells surround this cell and the newly-hatched larvae thus come to occupy the row of cells next to the newly-added cells in which fresh eggs are laid. The just-hatched larva measures 4 mm. in length and is pale white in colour. The head is more or less rounded and marked off from the body by a constriction between, the body is somewhat flattened and the tail end is attached to the cell wall. A young grub of six days' growth is 12 mm. long and is comparatively broader. The whole body has a sordid yellowish-whire colour except the mandibles which are brownish. The tail end is still attached to the cell wall and the body segments are wrinkled at the abdominal region. The segments show a tendency to project laterally. A grub of 20 mm. is flattened further and slightly curved. The abdominal region shows tubercular projections laterally and the tail end is forked. A full grown grub before pupation measures 30 to 32 mm. in length and 10 mm. in breadth. The general colour is yellowish-white, the head light brown, the mandibles dark brown, and the spiracles light brown. The row of fleshy tubercles on each side along the latero-ventral line of the abdomen is clear and six of them are distinct on each side. The median dorsal region of each of the abdominal segments is also slightly raised. The tail projections are still retained. Body is smooth and fleshy. I have noticed that the full-grown grubs have the peculiar habit of producing a sort of rustling noise after regular intervals. When disturbed the full-grown grubs often exhibit the habit of capping their cells. One capped cell which I opened at 8 A.M. was found recapped by 9·30.

The pupal cell is 33 mm. long of which the lower 25 mm. has a brownish colour while the upper third is whitish and more or less composed of pure silk. Before the final moulting to form the pupa the full-grown grub caps its cell. The pupa inside the pupal case is 30 mm. in length and yellowish-white in colour, the eyes brownish as are also the tips of the mandibles. The wing pads are yellowish-white and light brown at the base, reaching the base of the first abdominal segment. The hinder legs reach the base of the last abdominal segment. Unfortunately, further observations on the insect were prevented, due to an unexpected accident to the nest.



***Glyptomorpha deesæ*, Cam., parasitic on *Chilo* in *cholam*, magnified about 3 diameters.**

38.—SHORT NOTES ON SOME SOUTH INDIAN INSECTS.

By T. V. Ramakrishna Ayyar, B.A., F.E.S., F.Z.S., *Assistant Entomologist, Madras.*

(Plates 19-22.)

The following form a few of the observations and records made by the writer on some South Indian insects during the past two years and this paper is intended to form a sort of supplement to the paper on "short notes on new and known insects from South India" submitted to the Fourth Entomological Meeting in 1921.

Hymenoptera. Some special attention having been devoted to the study of the bionomics and systematic study of Parasitic Hymenoptera, especially those having some economic importance, a considerable amount of material has been gathered and observations made. The following are some of the important parasites worth notice among those noted till now. On the *cholam* stem-boring Pyralid caterpillars, the following three insects have been noted, so far :—(*a*) *Xanthopimpla nursei,* Cameron (Ichneumonidæ). This is fairly common and is responsible in checking species like *Chilo simplex* effectively in certain seasons. Among Braconids on the Pyralid *Glyptomorpha deesae,* Cam. (Plate 19), and *Iphiaulax spilocephalus,* Cam., are the chief in South India. The former is easily mistaken for *Glyptomorpha nicevillei,* Bingham, figured in Lefroy's *Indian Insect Life,* p. 178, although it differs from *nicevillei* in being bigger and in the absence of the black colour on the head and at the tip of the abdomen. *G. nicevillei* is also common in South India but does not appear to be so common as *deesae,* at any rate in *cholam* fields. I have noticed *nicevillei* in paddy and cane fields in Malabar and South Kanara. *I. spilocephalus* is a stouter-built insect and is not so common as *deesae* in *cholam* fields.

(*b*) *Glyptomorpha smeenus,* Cam. This Braconid confines its attacks chiefly to Buprestid grubs. It has been noted on species of *Sphenoptera* on stems of groundnut, red grâm, and other pulses in different parts of South India. The parasite figured in plate XX in Lefroy's *Indian Insect Life* is undoubtedly a *Glyptomorpha* and most likely *smeenus* itself.

(*c*) *Philomacroplœa basimacula,* Cam., (Plate 20). This interesting little Braconid confines its attacks to the Danaine butterflies such as *Euploea, Danais,* etc., and is got in numbers very often. It appears to be the same as *Chelonogastra,* Ash., and is easily liable to be

mistaken for a species of *Chelonus*. The previous record of this insect is from Ceylon. (See *Spol. Zeyl.*, III, page 87 ; 1905).

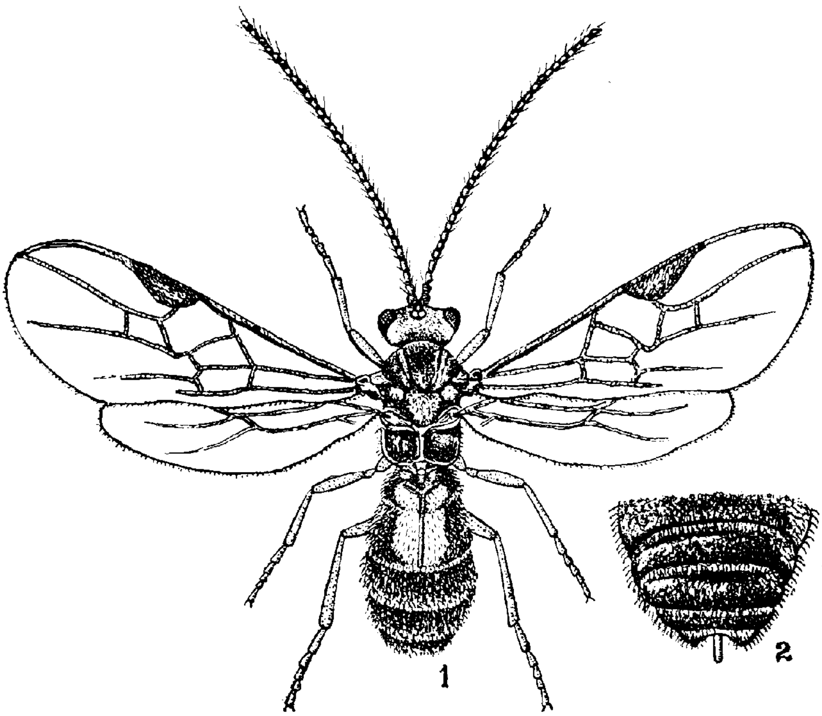
Troporhogas maculipennis, Cam. (?) This fairly large but delicately built Braconid was reared from the pupa of *Daphnis nerii*. In all sixty-eight specimens of this parasite emerged from a single caterpillar, about half the number being males ; the caterpillar was turned into a spongy cylinder covered with numerous holes. The male parasite has the joints of its maxillary palpi extraordinarily swollen. (See Plate 21).

Microplitis eusirus, Lyle. On page 31 of the report of the last Entomological meeting I have figured and noted this insect. Mr. Lyle has recently described it as *M. eusirus* in a recent issue of the Bulletin of Entomological Research, 1921.

Scutellista cyanea, Mots. (Plate 22). This small stout built Chalcidid is an extremely efficient check on the multiplication of different species of *Lecanium* in South India. I have noted this in my Bulletin on South Indian Coccidae (*Pusa Bulletin No. 87*, p. 32) when referring to *L. nigrum*. I have recently reared it in numbers from *L. oleae*, B. The eggs of the Coccid are devoured in numbers by the parasitic grub. Almost every cotton season this parasite does a considerable amount of beneficial work in checking *L. nigrum*, which is often a bad pest of cotton plants in Coimbatore. Some points in the life-history of this parasite have also been noted. The pupá takes 10 days to emerge as an adult.

The teak gall insect (Cynipid ?). In July 1921 while touring in the Tinnevelly hills I noticed numerous teak trees in some of the reserved forests showing numerous galls on the branches, and in some cases single trees showed numerous galls on the branches. These galls varied from the size of a small lemon to that of a tennis ball. Some of the trees showed no foliage and had numerous galls. It appeared to me that the trees were being injured to some extent by this gall formation. Though these structures are hard to the touch, on cutting open they show a spongy cellular structure ; in some fresh ones I noticed small whitish grubs which are, so far as I could make out, Hymenopterous grubs. I tried to rear them but failed. I think they are perhaps Cynipids. I am trying to get some more galls and rear out the insects. From an economic point of view I think these galls are worth investigation since a considerable area of teak in the Tinnevelly hills show this abnormal gall formation (Plate 22).

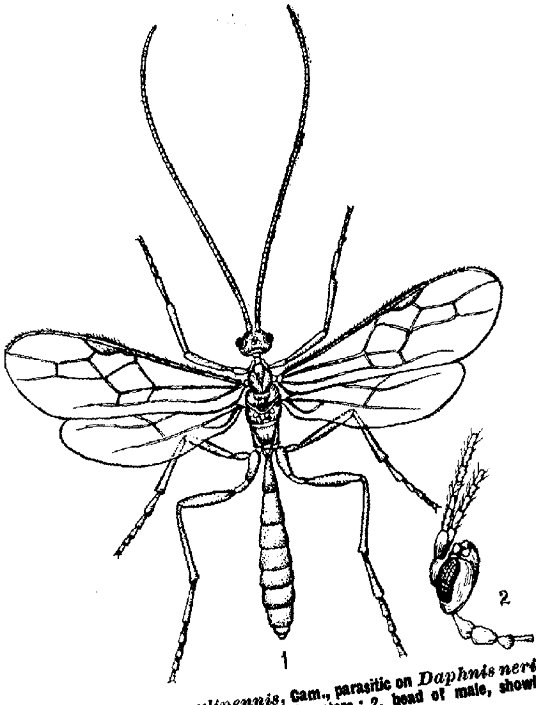
Coleoptera. Cantharis setacea. This Blister Beetle was found in numbers attacking cow peas and red gram in a hill area in the uplands of Godavari in the month of September. The pods of cow pea were literally devoured in numbers by these beetles. I do not think this species has been noted as a pest till now.



Philomacroplœa basimacula, **Cam., parasitic on Danaine butterflies ; 1, the adult insect, magnified about 12 diameters ; 2, anal invagination, more highly magnified.**

Page 265.

PLATE 21



Troporhogas maculipennis, Cam., parasitic on *Daphnis nerii*; 1, the adult insect, magnified 6 diameters; 2, head of male, showing swollen palpi, more highly magnified.

Olenecamptus bilobus. This longicorn beetle was observed by me recently as a serious pest of mulberry plants in the Godavari District. Of course they were not found in a regular mulberry-growing garden, they were only found on stray trees. But the attack was very bad. Several grubs, pupae and adults were collected from each of the stems, and the latter were found dried up. This is, I believe, the first record of this insect on mulberry.

The yam Galerucid (Chysomelid). While touring in the Godavari delta in September 1921 I noticed yam plants (Elephant-foot yam) with their leaves eaten and in some cases the plants and leaf stalks rotting. On closer examination it was found to be the work of the larvae and adults of a Chysomelid beetle. The grubs are dark and smooth and are found in numbers feeding gregariously on the foliage and often eating into the succulent leaf stalks. The adult beetle, which is reddish brown with black markings, is about 8 mm. long and very active. It eats holes in the foliage. I believe this insect to be a new pest and not noted before anywhere as far as I am aware. The insect was found in gardens of the Amalapur Taluq in the Godavari delta tract. Specimens were sent to Pusa for identification but it was only made out as a Galerucid and not named.

Epistictia seicheana, Guer. The fleshy stout built grub of this Cassidine leaf-beetle was found in numbers on a wild shrub on the Courtallum hills in Tinnevelly. The adult beetle is easily reared. The beetle has a light yellowish-brown colour with numerous patches of metallic blue on the elytra. The grubs behave more or less in the same way as those of the common tortoise beetle, *Aspidomorpha miliaris.*

Lepidoptera. Ophideres spp. Moths of this Noctuid genus were noted to do very serious damage to ripening oranges in the uplands of the Godavari and Kistna Districts in August-September 1921. The species chiefly concerned was *O. fullonica.* The moths fly at night, puncture the fruits and suck up the juice. The fruits as a result rot and gradually drop down. In some gardens I noticed that in the case of valuable paying fruits each fruit is protected by a small bamboo wicker pouch to keep away the moths, each pouch costing less than a pice. Even this last season there were reports about this pest.

Catephia inquieta. The caterpillars of this Noctuid moth were found in some numbers on the sweet potato crop grown on the Central Farm. Coimbatore, in 1921. Though I have noted spray specimens of this insect on this crop as early as 1906 in Koilpatti, I have not noted it as a really injurious insect till recently.

Hippotion celerio was recently noted in numbers on grape-vine foliage in some of the household gardens in Coimbatore, defoliating the vines.

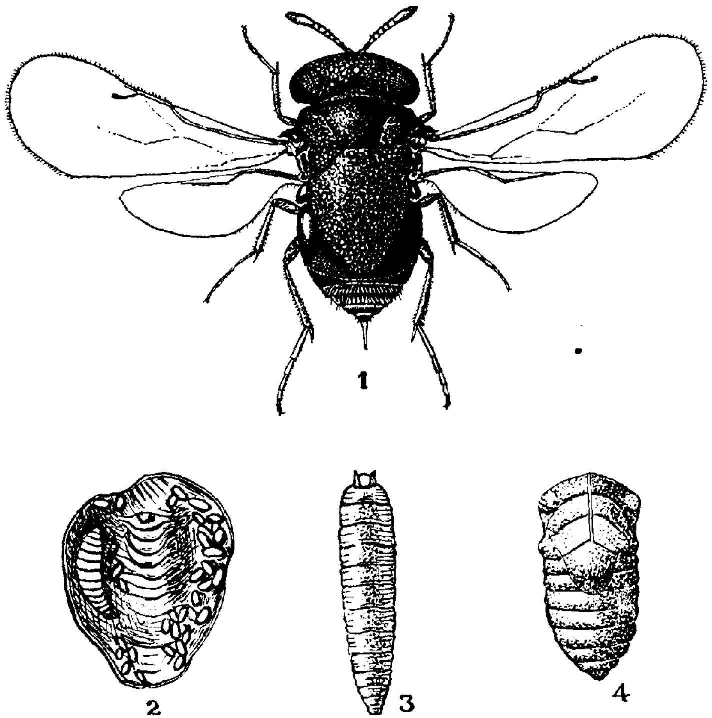
Glyphodes laticostalis. Thousands of the caterpillars of this Pyralid moth were noted on a forest tree in Malabar. The caterpillars are leaf-rollers and often found gregariously. In general appearance the moth resembles *Glyphodes indica,* although bigger and coloured somewhat differently. It was found as a bad pest. The caterpillars are very active and behave like the cotton leaf-roller (*Sylepta*), wriggling inside the leaf-roll and often dropping down.

Meridarchis scyrodes. The fruits of the bér tree (*Zizyphus jujuba*) are very badly infested by the pink caterpillar of this in Coimbatore. Sometimes more than one caterpillar is found inside one fruit and often the caterpillar is found in company with the larvae of *Carpomyia vesuviana.* Both these boring larvae are also found parasitized each by a Braconid, the caterpillar by a *Microbracon* ? and the Trypetid by *Opius fletcheri.* More than forty per cent. of this wild grown fruit brought to the market is found damaged by these two boring larvae.

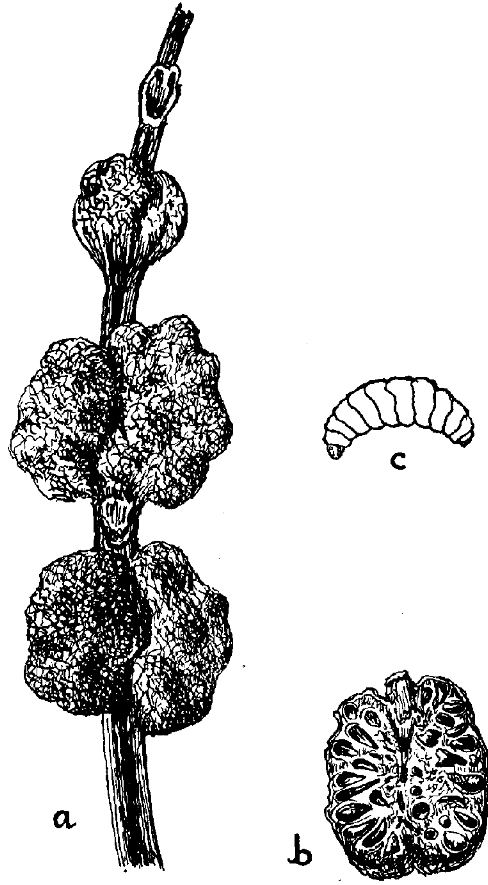
Phassus malabaricus. Recently this Hepialid moth was noted as a pest in the Dhony valley in Malabar. The stout long fleshy caterpillar was found boring into the stem of young *melaina* (*Gmelina arborea*) trees, very soft-wooded trees which are being grown by the Forest Department on an experimental area. In the nurseries where these plants were grown the pest was found doing serious damage. The caterpillar commonly bores down into the stem below the soil level but shows its presence by the heap of wood-dust at the bore entrance. Occasionally it is found at the junction of two low branches. I noted the same insect on the Nilgiris four years ago on a species of *Cassia* but was not then sure what the insect was. Though I collected several pupae I was not able to rear out the moth.

Diptera. Pongamia gall-fly. This insect, which I have referred to in p. 37 of the *Report of the Fourth Entomological Meeting,* has now been identified by Prof. Felt of New York as *Asphondylia pongamiae* (vide *Pusa Memoir,* Vol. VII, p. 24). Other gall-flies submitted by me and named by Prof. Felt in the same publication are (1) *Camptomyia ricini,* reared on dry castor stems, Coimbatore, March 1920, and (2) *Cecidomyia artocarpi,* reared from rotting Jak fruit, Kotipalli, Godavari District, January 1918.

Rhynchota. Coptosoma ostensum, Dist. This small Pentatomid (see my ref., *vide Report of Third Meeting,* p. 325) has been found for the past two years to be a very bad pest of *Butea frondosa* in Coimbatore. A few trees in the College compound are literally covered with millions of this bug and their nymphs every year in March-April. Attacked leaves turn brown and gradually drop till at last by about middle of March almost all leaves appear dry and sickly. They are generally



Scutellista cyanea, Mots. ; 1, adult, ×22 ; 2, a scale-insect showing the eggs and larva of the parasite inside it, ×6 ; 3, larva, ×22 ; 4, pupa, ×18.



Tinnevelly Teak Gall ; *a*, galls on stem ; *b*, gall cut open, showing cells with grubs ; *c*, a grub removed from cell, magnified.

found on the back of the leaves. The nymphs are more or less like those of *C. cribraria* but the eggs appear different especially in being grooved on the surface.

Antestia cruciata. This Pentatomid, which is noted often on coffee in the Hills, was recently found doing some damage to garden jasmines grown by flower dealers near Coimbatore. The bugs are found on the young shoots and flower buds, puncturing them and sucking the juice. This was first noted in April 1921.

Jurtina indica, Dall. I noted this Pentatomid bug attacking pomegranate fruits in a fruit garden in Panayam, Kurnul District, in October 1921. The insect when casually observed is easily mistaken for *Nezara viridula* which it very closely resembles (See Distant, *Fauna*, Volume I, p. 224, fig. 141). It has, however, got pronotal margins and the feelers violaceous and on the scutellum there are two blue-black spots. The insect was found in some numbers puncturing the ripening fruits. This appears to be the first record of the insect from South India.

Halyomorpha picus. This bug was also noted in the same situation as above on pomegranate puncturing tender and ripening fruits.

Bredenbachius delineatus, Dist. This small Tingidid bug is commonly found in colonies on the leaves of *Cordia myxa*, a common garden plant in Coimbatore. All stages are found together. Very young nymphs have a pinkish-brown colour with the legs, feelers, and spines shining white. For figure see page 120, Distant's *Fauna*, Vol. V on Rhynchota. This bug and the Psyllid peculiar to *Cordia* plants in Coimbatore, *Euphalerus citri*, K., often cause some appreciable damage to these plants almost every year.

Ricania bicolorata. In a short paper on some Swarming Fulgorid bugs which I read before the Third Entomological Meeting in 1919 I have made reference to this Fulgorid bug as being found in numbers in almost every plant on the lower slopes of the Nilgiris during the early summer months. I have had one or two opportunities of visiting the tract afterwards in February and March and was able to note the earlier stages of the insect. During the months February-April I was told that almost all the trees along the Nilgiris Slope between 1,500 and 3,000 feet are found covered with the larvae of this bug. The plants that suffer most are coffee, jak, and *Citrus*. On young coffee plants which are just putting out their fresh shoots and are about to bloom this insect is found to do some appreciable injury. The whole foliage is covered with colonies of these nymphs and the damage to the plants consists in the juice being sucked and the whole plant surface covered with a sticky juice, attracting fungi and other insects. The effect is exactly as in the case of the effect of mangohopper attack or damage

by scale insects like *Pulvinaria psidii*. The young ones are creatures with a curious appearance; the anal processes and tufts especially are very elaborate and provided with long waxy filaments. At a distance the leaf surface containing the young larvae appear to be covered over by pieces of cotton wool sticking out in the air. I have not so far seen anything about the bionomics of this insect on record. I believe, it may be put down as a minor pest of coffee on the Nilgiris.

Coccidae. Numerous Coccids have been noted during the past two years and I am contributing a separate paper noting the recent records from South India in another paper this year.

White-flies. In Southern India so far, I have come across the following important finds of *Aleyrodidae* on plants of economic importance :—

(1) *On castor*. This is well-known and common and requires no comment.

(2) *On Citrus*. This is probably *Aleurocanthus spiniferus* noted from North India. Though not so common, it is found here in South India. On a plant called *Hiptage madabulata* a similar spiny black species is found. The puparia are bluish-black with white-fluff at the edges and the adult is pink with bluish opaque wings.

(3) *On Phyllanthus dischichus*. A pretty garden plant grown as an ornamental garden tree and for its fruits. On this plant I found a species of white-fly as a very bad pest in the Botanical garden, Coimbatore. The adults are light yellowish in colour. Only the back of the leaves is infested. The early nymphal stages have a bluish-white fluff. The eggs are laid in incomplete circles and ovals and attached to the leaf by their long axis. Young shoots of the infested plant present a very sickly appearance.

(4) *On pomegranate*. This plant is also often subject to the attacks of a white-fly. The adults are similar in appearance to the one on *Phyllanthus* plant noted above. Noted at Coimbatore.

(5) *On jasmine*. On garden jasmine a species of white-fly is found. The nymphal cases are smooth and light yellow in colour and found by the hundred on the backs of infested leaves. Noted at Coimbatore and Bangalore.

(6) *On Eugenia jambolana*, probably *Dialeurodes aurantii*, in parts of Mysore. I have made mention of this and the one on *Bassia* also in the *Report of the Third Entomological Meeting*, p. 326.

(7) *On sugarcane. Aleyrodes barodensis* and *Neomaskellia bergi* are fairly well known. This group Aleyrodidæ offers a very interesting and unexplored field for investigation and as some of them are of economic importance this study might prove advantageous in various ways.

Chermes sp. (Aphididæ). A species of *Chermes*, probably the first record of this Aphid in South India, was noted by me doing some serious damage to Pine trees in the Pasteur Institute at Coonoor in May 1922. I took the insects to be a species of mealy bug, *Pseudococcus*, but on sending them for identification I understand from Mr. E. E. Green that the insect is a species of *Chermes* (Aphid) and not a Coccid. The only reference I have found to species of *Chermes* in India is in *Indian Museum Notes*, Vol. III, p. 54 (5), p. 96 (2) ; *Chermes abietis*, L., on spruce fir from N.-W. Himalayas. The insect in Coonoor was doing some damage to the trees and some fungus was also found in company with this insect. Spraying was tried to check the disease.

Phyllochoreia ramakrishnae, Bol. (Acrididæ). On page 39 of the *Report of the Fourth Entomological Meeting* I have referred to a new *Phyllochoreia* and stated that it might be a new species. It has recently been found that this form (fig. 2 in the above reference) is the female of the one referred to (figure, plate 175) in the *Report of the Third Entomological Meeting* as *P. ramakrishnai*, Bol. The sexual difference is apparently very striking and one is liable to mistake the two for two different species.

Thysanoptera. Out of the material I collected and submitted to Mr. Bagnall in 1919 the following forms have since been described by him in the *Annals and Magazine of Natural History* for 1921, in addition to those previously described.

Dolichothrips varipes, on a wild plant, Malabar.

Physothrips minor. Inside the tender leaves of the common South Indian creeper, *Ipomœa staphylina* ; collected in Coimbatore and Maddur.

39.—A FURTHER CONTRIBUTION TO A KNOWLEDGE OF SOUTH INDIAN GRASS GALL MIDGES.

By Rao Sahib Y. RAMACHANDRA RAO, M.A., F.E.S., *Act. Govt. Entomologist, Madras.*

A paper was read by me on this subject at the Fourth session of the Indian Science Congress which met at Bangalore in 1917. Since then, I have, during my leisure hours, continued my work on similar galls and it is the object of this paper to set forth the results of my observations.

As observed in my first paper, a search for these grass galls was made in the endeavour to find out the host plant for *Pachydiplosis oryzae*, the gall fly causing the silvershoots in paddy. In my last paper, *Panicum stagninum* was recorded to be an alternative host plant for this gall midge. Since then, Dr. Felt of Albany, N. Y. (*Entl. Memoir of Agri. Dept., India*, Vol. VII, No. 3) has identified a gall midge recorded by me from *Ophiurus corymbosus* at Kavitum, in the Kistna District, to be *Pachydiplosis oryzae*. Though this grass was found on a raised embankment in the midst of Rice fields, yet it is in its habits only an upland grass found in dry areas. Hence the identification was subjected to a query by Dr. Felt himself and by Mr. Ballard in the memoir quoted above.

Though *Panicum stagninum* was noted to produce galls in abundance at Samalkota in October 1916, yet examination of the same grass at Coimbatore and at Samalkota subsequently (July 1919, and November 1921) did not reveal the presence of the galls. Hence it would appear to be only a casual host of the silvershoot fly and not to function as the regular carrier of the pest during the absence of paddy in the fields. If *Ophiurus corymbosus* be confirmed as one of the host plants, it is perhaps more likely to harbour the pest in the off season. In the absence, of course, of other grasses, wild paddy, wherever it may occur, is very likely to function as the host at times when paddy is not present on the ground.

However, a mere knowledge of the existence of alternative host plants for the paddy gall fly does not help one much in understanding how the pest recurs year after year. It would be of greater practical importance to know how exactly these grasses help the gall fly to tide over the hot season, for during the dry hot summer most of the grasses become parched up and a continuance of breeding of flies on these grasses in summer would appear to be an impossibility.

In connection with the gall fly, *Hormomyia ischaemi*, reared from *Ischaemum pilosum* in the Bellary District, I had remarked as follows

in 1917 : "This fly seems to breed only in the Rains and how it passes the long dry season in these arid plains is a mystery. Possibly the young larvae remain quiescent in the nascent buds underground and develop when the latter shoot out after the rains." Further observations, especially the fact that these galls emerge along with the first shoots put forth by the underground stolons after the early rains, have confirmed me in this view.

This grass, however, does not occur at Coimbatore and experiments to find out whether this hypothesis was correct could not be undertaken, but another grass, *Pennisetum cenchroides*, one of the common fodder grasses, was observed to be subject to similar galls at Coimbatore. It was also noted that in the dry hot months of March-April, this grass dried up almost completely and that, when rains were received, it put forth shoots once again and with the shoots some of the galls also were observed to appear. It was therefore proposed to make observations on this grass to find out if the theory above mentioned was founded on facts.

Several clumps of this grass were dug out towards the end of March 1922 and after thorough examination planted in pots. Traces, if any, of old galls were removed and all existing shoots were cut out. The potted plants were after thorough examination placed in cages protected by wire gauze on 3rd April 1922. By the 19th April the grass had revived and fresh shoots had been produced. Amidst such shoots fresh galls had also developed from which the gall flies were reared out a few days later. Some of the galls had emerged even from below the surface of the soil. In these cases, there was absolutely no ground for suspecting that these galls had developed from fresh eggs laid by flies, as the wire gauze precluded the entrance of any from outside, even if any could have been found in the hot days of summer. To my mind it looks as if no other explanation can be offered than that the young maggots bide their time inside the dormant buds and that when, with the advent of the rains or after hand-watering, the grass is stimulated to produce its shoots, these larvae also develop and cause the formation of the galls. This explanation is strengthened by the peculiar habits of the newly-hatched larvae, which soon after hatching from eggs (which are generally laid on the leaves, leafsheaths or ligules) crawl down along the leaves and stems and try to find entrance into any of the buds. apical or axillary. Though two or more may compete for the occupation of the same bud it is generally only one that ultimately occupies it. The further development of the galls seems to be entirely dependent on the time when the plant happens to direct its sap to the growth of the nascent buds.

The following is a list of grasses in which galls were observed and, where data are available, the identifications of the flies reared out are also given :—

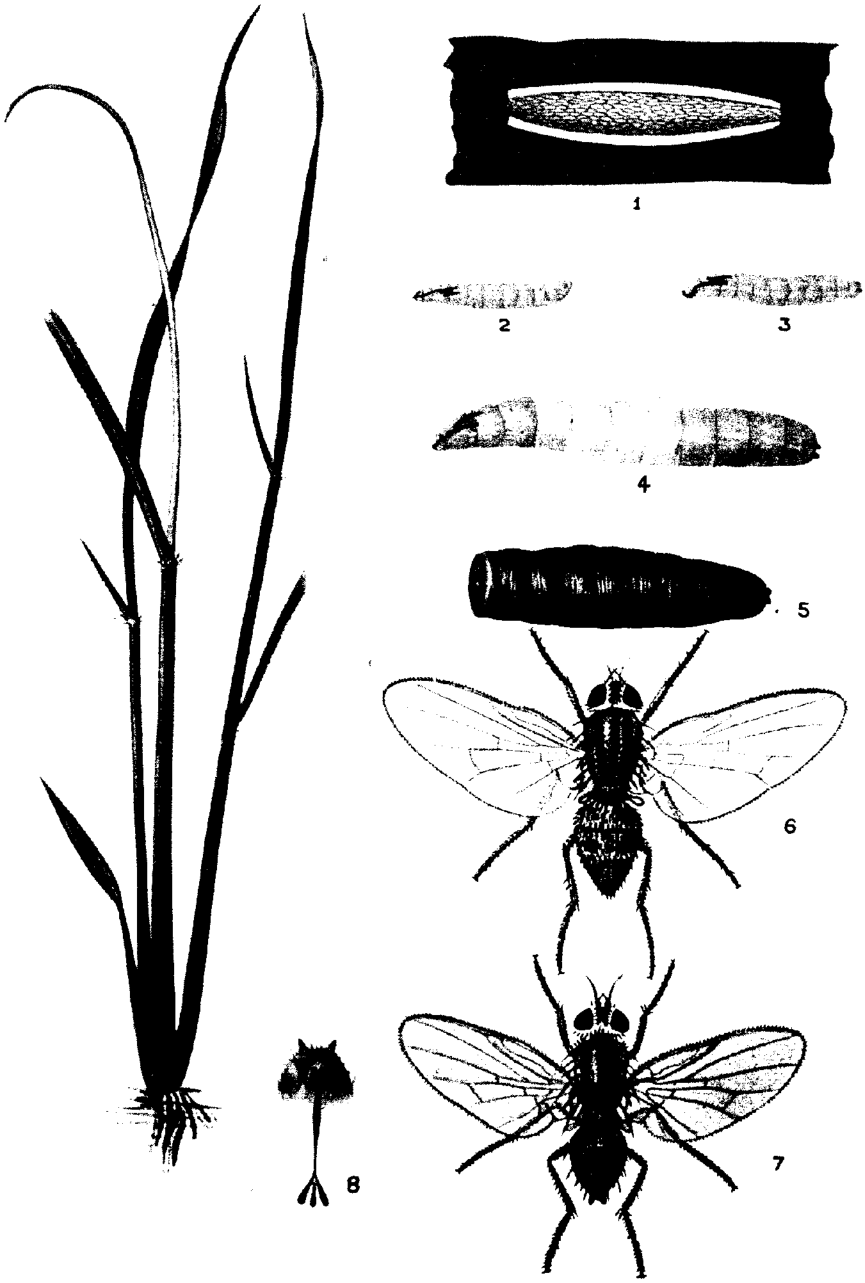
Serial No.	Name of Grass. Genus.	Name of Grass. Species.	Were gall midges reared out ?	The Gall Midges reared out. Genus.	The Gall Midges reared out. Species.	Locality.	Remarks.
1	*Andropogon* .	*annulatus* .	Yes .	*Dyodiplosis*	*andropoginis*, Felt .	S. India . .	1917 paper.
	...	...	Yes .	...	*plumosa*, Felt .	Samalkota and Kistna District.	Later rearings, Mem., Vol. VII, No. 3.
2	...	*contortus* .	Yes .	...	*andropoginis*, Felt .	Adoni . .	Later Rearings.
3	...	*monticola* .	Yes .	...	*monticola*, Felt .	Muruvani .	Later rearings, Mem., Vol. VII, No. 3.
4	...	*pertusus* . .	Yes .	...	*andropoginis*, Felt .	Coimbatore	1917 paper.
5	...	*squarrosus* .	Yes .	*Orseoliella* .	*graminis*, Felt .	Adoni. Atchanta .	Later rearings, Mem., Vol. VII, No. 3.
6	*Aplude* . .	*varia* . .	Yes .	*Orseoliella* .	*apludae*, Felt .	South India .	1917 paper.
7	*Cymbopogon gaesius Schoenanthus.*	*Andropogon*	Yes .	*Dyodiplosis* .	*andropoginis*, Felt .	South India .	1917 paper.
8	*Cynodon* . .	*dactylon* .	Yes .	*Orseolia* . .	*cynodontis* . .	Coimbatore .	1917 paper.
	...	...	...	*Pachydiplosis* .	*graminicola*, Kieff and Mass.	South India .	Mem., VII, No. 3.
9	*Eragrostis*	*amabilis* . .	Yes .	*Pachydiplosis* .	not yet identified .	Mangalore .	Reared Aug. 1922.
10	*Imperata*	*arundinacea* .	Yes .	*Orseoliella javanica*, Kieff and Leeuw		Kistna District.	Later rearing, Mem., VII, No. 3.
11	*Ischaemum*	*ciliare* . .	Yes .	*Dyodiplosis* .	*cornea*, Felt . .	Coimbatore .	1917 paper.
12	...	*pilosum* . .	Yes .	*Hormomyia* .	*ischaemi*, Kieff .	Bellary . .	1917 paper.

13	*Iseilema*	*laxum*	Yes	*Dyodiplosis*	*plumosa*, Felt	Atchanta	Later rearing, Mem., Vol. VII, No. 3.
14	...	*anthephoroides*	No	...	...	Pattikonda Karnul Dt.	1917 paper.
15	*Iseilema* ?	not identified	Yes	Not identified	..	Palur, South Arcot	1917 paper.
16	*Ophiurus*	*corymbosus*	Not reared.	...	...	Pattikonda Karnul District.	1917 paper.
	...	...	Yes	*Pachydiplosis oryzae*, Wood Mason		Kistna District.	Later rearings, Mem., Vol. VII, No. 3.
17	*Oryza*	*sativa*	Yes	*Pachydiplosis oryzae*, Wood Mason		S. India and Bengal.	1917 paper.
18	*Panicum*	*flavidum*	Yes	*Dyodiplosis andropoginis*		Samalkota, Atchanta.	Later rearings, Mem., VII, No. 3.
19	...	*fluitans*	Yes	...	*flavidalis*, Felt	Coimbatore, Bellary.	1917 paper.
20	...	*punctatum*	Yes	...	...	Samalkota	1917 paper.
21	...	*stagninum*	Yes	*Pachydiplosis oryzae*, Wood Mason		Samalkota	1917 paper.
22	? *Panicum* not identified, Local name " *Yenuga-Mokalu* "		Yes	Sent up to Prof. E. P. Felt for favour of determination.		Samalkota	Recent rearings.
23	*Paspalum scrobiculatum*		Yes	*Pachydiplosis* ? Sent to Prof. Felt		Samalkota, Coimbatore.	Recent rearings.
24	*Pennisetum conchroides*		Yes	Sent to Prof. E. P. Felt		Coimbatore	Recent rearing.
25	*Themeda imberbis* (*anthistiria*)		No	Not reared		Dodballapur (Mysore).	Only pupal skins are available.
				JAVAN REARINGS.			
1	*Oplismenus compositus* (a very common grass in India).		...	*Orseoliella orientalis*, Felt		Buitenzorg	*Treubia*, Vol. II, 1.
2	*Panicum nodosum* (also found in India).		...	*Courteia graminis*, Kieff and Leeuw.		Java.	
3	*Panicum indicum* (a very common grass in India).		...	*Parallelodiplosis javanica*, Felt		Buitenzorg	*Treubia*, Vol. II, 1.
4	*Paspalum scrobiculatum* (very common in India).		...	*Parallelodiplosis paspali*, Felt		Buitenzorg	*Treubia*, Vol. II, 1.

The thanks of the writer are due to Prof. E. P. Felt for his kindness in determining all the galls reared out.

His thanks are also due to Mr. A. H. Sundararaman, Research Student, Calcutta, for help given in collecting galls and examining them for recording botanical characters. He has recorded galls in *Ischæmum pilosum* from Saranath (Benares) and on *Cynodon dactylon* from Allahabad and Calcutta.

In this list I have included four different grasses in which Dr. W. Docters Van Leeuwen of Buitenzorg, Java, has recorded galls and reared out of the gall midges. Of these grasses, *Paspalum* galls have been included in my list of Indian galls and, as the other three species also occur in India, gall formations may probably be discovered in them in India also after further investigation.



RICE STEM FLY (*ATHERIGONA* SP.)

EXPLANATION OF PLATE 23.

Atherigona sp. (Rice Stem Fly)

1. Egg × 30.
2. Larva, first instar, ×14
3. ,, , second ,, , ×14.
4. ,, , third ,, , ×10
5. Puparium × 10.
6. Female Fly × 10.
7. Male Fly × 10.
8. Genital bristle of the male Fly × 20
9. Attacked paddy seedling.

40.—A PRELIMINARY NOTE ON THE LIFE-HISTORY OF CERTAIN ANTHOMYIAD FLIES, *ATHERIGONA* SPP. AND *ACRITOCHAETA EXCISA*, THOMSON.

By E. Ballard, B.A., F.E.S., *Government Entomologist, Madras* (*on leave*) *and* Rao Sahib Y. Ramachandra Rao, M.A., F.E.S., *Acting Govt. Entomologist, Madras.*

(Plate 23.)

The present paper is meant to be a preliminary note summarizing the results of observations made at Coimbatore on the life-history of these very interesting flies at various times between the years 1914 and 1921, and it is proposed to publish the results in a more detailed and fuller form sometime later, after supplementing the information by further work on the subject.

The Anthomyiad flies, of which a life-history study was made at Coimbatore, are four in number. Owing to the reason that these flies could not be identified, till Mr. J. R. Malloch of the Bureau of Biological Survey, Washington, U. S. A., kindly undertook recently to name them, they were distinguished for the sake of convenience as the "*Cholam* Fly" (*Cholam*, *Andropogon Sorghum*) the "*Cumbu* Fly" (*Cumbu*, *Pennisetum typhoideum*), the Rice-Stem Fly (Rice, *Oryza sativa*) and the "Tomato Fly," associating them with their particular food plants. The first three flies have been determined by Mr. Malloch to be species of *Atherigona*, Rondani, and the last, which feeds on decaying fruits or vegetable matter, as *Acritochaeta excisa*, Thomson, (*pulvinata*, Grimshaw), "a species which is very widely distributed in the Tropics, extending its range into North America" (Malloch.)

These flies as well as several other species of *Atherigona* which have since been differentiated by the form of the genital bristle, look extraordinarily alike and cannot be easily distinguished by external characters alone, and were in the beginning regarded as a single species, *viz.*, the "*Cholam* Fly", which was supposed to have a variety of food plants and to breed also in decaying matter.

In 1914, the life-history of the "*Cholam* Fly" was taken up and in the course of the investigation Flies reared from "*Cumbu*" (*Pennisetum typhoideum*) were in 1915 differentiated from the *Cholam* Fly by certain differences in the sculpture of the egg and the structure of the larval pharyngeal skeleton. Moreover, physiological differences were discovered, for the flies preferred only their own particular food-plants

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and selected them for oviposition. Later on, in 1915, the fly breeding in rotting Tomato fruits was similarly differentiated for the same reasons. Life-history work from 1916 to 1920 could not be continued owing to the absence of the senior author on war work and the junior author on deputation on other duty. In 1920, the senior author discovered the "Rice Stem Fly" and in 1921 life-history work of this fly was taken up and completed as far as possible.

Life-history. Of the four flies studied, three oviposit on living plants (all Gramineae or grasses), the maggots boring in and causing deadhearts in the shoots, while the fourth oviposits on decaying matter and bruised fruits, in the substance of which the maggots breed, but phylogenetically the flies attacking grasses must have been evolved from those breeding in decaying matter, for in fact, the maggots of *Atherigona*, although they live in living plants, are in essence feeders on decaying matter, for the first work that the young maggots hatching from the eggs do, is to travel to the growing point of the shoot and sever the connection between it and the central shoot so that the latter withers and begins to rot, and it is in this decaying substance of the shoot that the maggot feeds and thrives. The main features of the life-history of all these flies are quite similar. The egg is elongate and somewhat torpedo-shaped and laid horizontally on leaves or fruits. The distal face of the egg is somewhat flattened and provided with two wings which run longitudinally and bound the flattened part. The sides of the egg under the wings is faintly ribbed, while the distal part between the wings is sculptured with a system of reticulations which varies somewhat in the different species. The colour of the egg is a beautiful opaque white. The micropyle is situated at the narrower end.

The larvae which hatch out are generally colourless, and possess only the posterior pair of spiracles, the anterior ones being absent. The pharyngeal skeleton is more elaborate in those attacking living plants than in the Tomato fly (*Acritochaeta*).

The maggot of the second instar develops the anterior pair of spiracles and the pharyngeal skeleton is somewhat less elaborate. The larvae of the third instar are more or less alike in all these flies and are stouter and larger. When mature the third instar larva turns into a puparium, generally in the substance of the material in which it feeds, whether shoots or fruit, but sometimes it descends to the ground and pupates in the soil. The flies emerge in about a week. The flies are lovers of sunlight and feed on honey dew or on any sweet substances. The flies generally live comparatively long, a month having been recorded under cage conditions, and probably in the field are longer lived The female lays 10 to 20 eggs at a stretch in the course of one or two

days, after which they cease to oviposit. After a few days the egg-laying is again resumed for a short period. Probably there are several such outbursts of egg-laying in nature.

The following are the salient points noted in the detailed life-history work done on the four species in question.

(1) *Cholam fly. Atherigona* sp. (*Sorghum*). Eggs about 1·2 mm. long; hatch in 36-44 hours. The larval period 6—10 days, the I instar occupying about 30 to 48 hours, the II instar about 36 to 48 hours, and the III instar about 3 to 4 days. The pupal period is about 6—7 days. From records obtainable the largest number of eggs laid by a female was 39. Maggots attack only young seedlings and shoots.

(2) *Cumbu Fly. Atherigona* sp. (*Pennisetum*). Flies smaller, eggs about 0·8 to 1 mm. long. Egg period 37 to 48 hours. The larval period about 7 to 9 days, pupal about 6 days. Maggots attack both young seedlings and grown-up plants. Ear-heads in shoot-blade are also attacked.

(3) Rice stem fly. *Atherigona* sp. (*Oryza*). (*Plate 23*) Egg 1 mm. long. Egg stage about 33-48 hours, larval stage 6—7 days, pupal 7 days; maximum egg record, 22. Maggots damage the paddy plant only in the seedling stage.

(4) *Tomato fly, Acritochaeta excisa.* Egg period about 28-36 hours. Larval period 6 to 7 days, pupal 6—7 days.

This fly breeds in various kinds of decaying matter, decaying fruit, decaying leaves, decaying shoots, etc., etc.

Later investigations have shown that the species noted in the past on other cereals such as *Panicum miliare, P. frumentaceum, and Paspalum scrobiculatum* are all different. A comparative study of the life-histories of these species may be of interest and will be taken up when opportunities offer themselves in future.

[See also Paper No. 48, pp. 330-335.]

41.—ON THE BIONOMICS AND TAXONOMY OF MUTILLIDAE WITH SPECIAL REFERENCE TO SOUTH INDIAN FORMS.

By T. V. RAMAKRISHNA AYYAR, B.A., F.E.S., *Assistant Entomologist, Madras.*

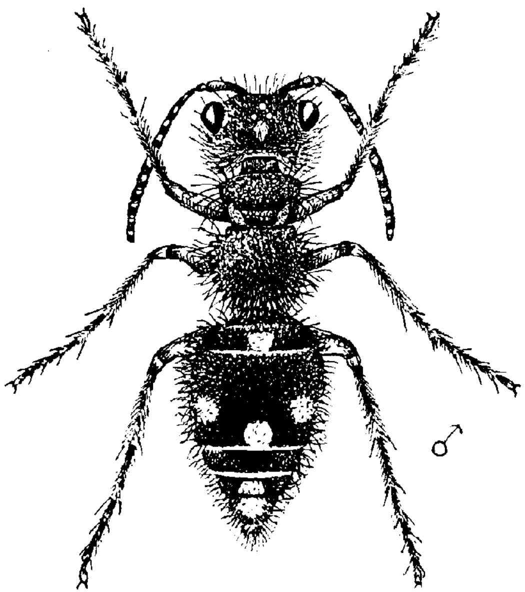
(Plates 24-25.)

An attempt is made in this short paper to bring together the few unconnected notes and observations made by the writer during the past few years on some of the South Indian Mutillidae, and they are here presented with the idea of inviting remarks and criticisms from workers in the same line in different parts of India.

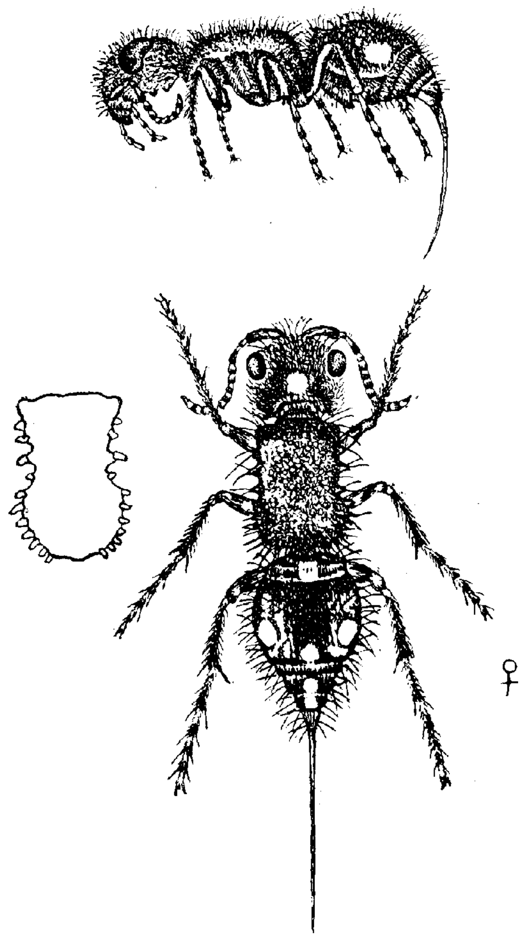
Mutillid wasps are fairly common all over South India. They have been collected from all sorts of places from forests and hills up to 5,000 feet (Malabar, Coorg, Nilgiris, Ganjam hills, etc.), in the open plains country, along the coastal tracts, and from the sandy beds of rivers in different parts of the Presidency. They are especially common in well exposed open arêas containing loose sand, mixed soil, and an indifferent growth of brushwood. The females are more commonly met with than the males. In the Plains and upland tracts these insects are more in evidence during the hot summer months. In the coastal tracts and on the Hills I have collected them in numbers on moist warm days after the south-west monsoons. The male Mutillid is generally dull and stupid on its wings and is easily netted. Not uncommonly a sweep of the net intended for a flying male brings in a pair, the small female grasped by the male during flight being unnoticed before.

Very little is known of the general habits of these insects excepting some generalisations drawn from isolated cases. They are parasitic in habits and the hosts so far known are Hymenoptera (wasps and bees). In Europe species of *Mutilla* have been in a few cases reared out of the nests of *Bombus*.

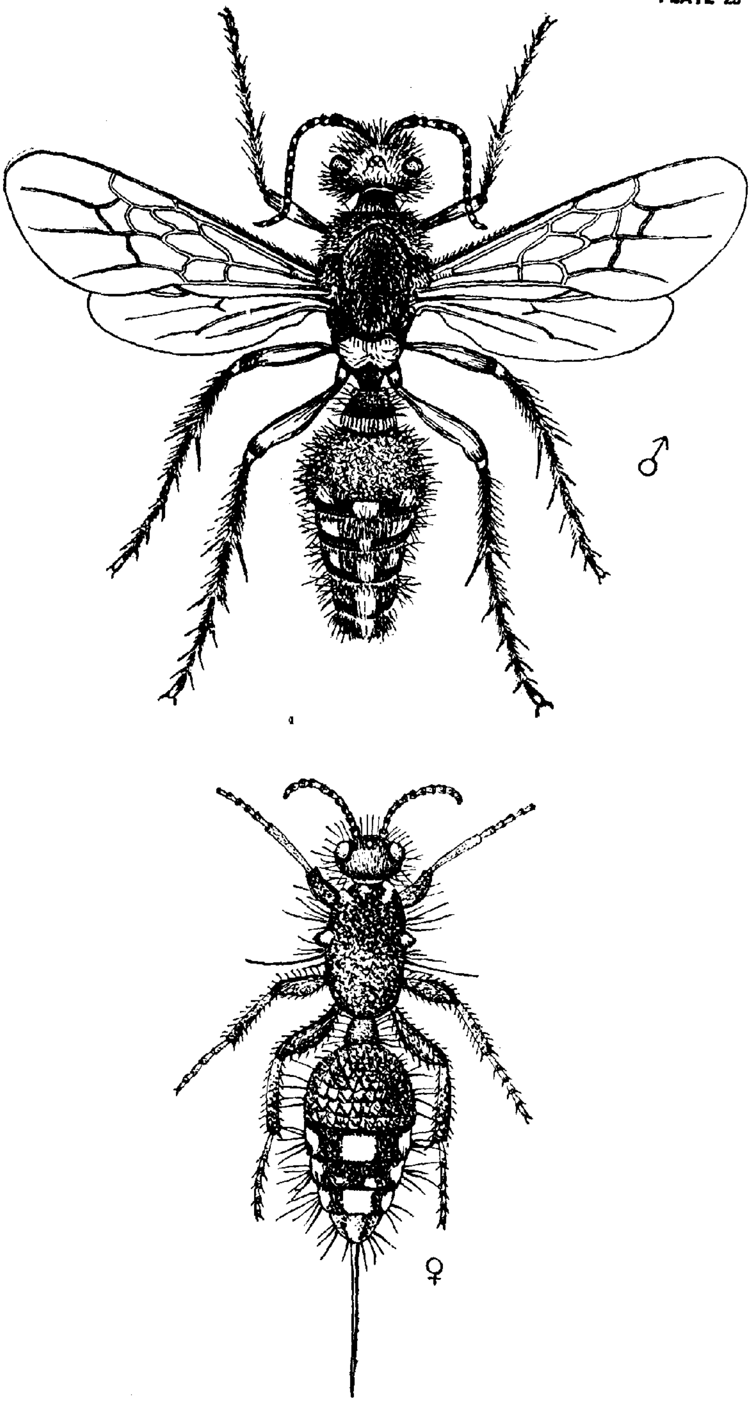
Before coming to the consideration of the classification of the family I might add a few words regarding a few forms of Mutillids which exhibit an exceptional feature, *viz.*, the absence of wings in both the sexes. Neither Lefroy nor Dutt have made any mention of such forms. We have in South India two or three species (perhaps varieties of species) which show this interesting feature. Ashmead had created the genus "*Spilomutilla*" to include some Asiatic forms showing this feature. In these forms the chief distinguishing difference between the sexes is the structure of the thorax which has its sides deeply grooved at the



Apterous male of *Spilomutilla* sp., magnified about 8 diameters.



Female of *Spilomutilla* sp.; lateral view (× about 7) and dorsal view (× about 8).



Dasylabris argentipes ; male (above) × about 7 ; female (below) × about 5.

sides, almost dividing it into two portions brought together by a narrow connection. These forms evidently represent species where the degeneration (the loss of both wings), probably brought about by peculiar habits of life, has proceeded a stage farther than normal in the family.

From the point of view of the systematist the existing records on Indian Mutillidae are unfortunately very chaotic and disappointing. All the Indian species described up to 1897 have been included by Bingham in the first volume on Hymenoptera in the *Fauna of British India* series published in 1897. All later records, chiefly by Cameron, Andre, Nurse and Turner, published in different scientific periodicals, have been listed by me in my "Catalogue of New Indian Wasps and Bees described since 1897", published in the *Bombay Natural History Society's Journal* in 1916. In Bingham's volume 120 species of the family (1 species of *Apterygona* and 119 of *Mutilla*) are included and the later additions, as may be found from my catalogue, number about 135 species. Thus, descriptions of over 250 Indian forms of the genus *Mutilla* are on record so far, although there is not the least doubt that a good many of this number are sure to be synonyms for various reasons.

As far as the writer of this paper has studied this group in South India, the following appear to be some of the more prominent structural peculiarities which might help a student working on this family to group together the species found in this Province; these refer especially to the females :—(1) Absence of wings in both sexes, (2) The structure of the 1st abdominal segment, (3) The comparative sizes of the head and thorax, (4) Armature of the head-teeth and spines on different parts of the head, (5) The size and shape of the thorax, the armature at the angles, at the sides and at the median truncation, (6) Shape of eyes and presence and absence of ocelli, (7) Shape of the scape of antennae, (8) Structure of the pygidium, (9) Structure of wings in males, (10) Pubescence and colour markings.

So far the following genera have been found to have their representatives in S. India besides the old genus *Mutilla* :—*Dasylabris, Promecilla, Odontomutilla, Spilomutilla.*

42.—LIFE-HISTORY OF *DANAIS LIMNIACE*, CRAM., AND ITS PARASITES.

By B. B. Bose, B.Sc., *Assistant to the Imperial Entomologist.*

(Plate 26.)

During the hot dry weather preceding the monsoon, the egg hatches about three days after deposition. Thus eggs laid on 6th May (8 A.M.) hatched on 9th May (morning).

The egg. The egg is generally laid on the lower surface of the leaf; it may also be laid, more rarely, on the upper surface. It is generally glued to the surface near the margin of the leaf on one side of the midrib. It measures 1·09 mm. in height and 0·93 mm. in breadth across the widest diameter. It is creamy white, nearly globular, slightly longer along its longitudinal axis and converging towards the apex. The base is round and flat and each egg is laid singly and one egg on one leaf only, as a rule, but in one case seven eggs were found on one leaf. Big or small leaves are indiscriminately chosen for egg-laying. The surface of the egg is marked by ribs running from the basal periphery and converging to the apex of the egg. In between these longitudinal ridges there are faint parallel striations situated one below the other. The longitudinal ridges do not meet each other at the apex but leave the micropylar circular area reticulated. The egg is set vertically on the surface of the leaf.

The larvae on hatching from the eggs at once attack the empty shells and in nearly all cases devour them to well near the bases beginning from the apex, and afterwards proceed to feed on tender leaves by the margin.

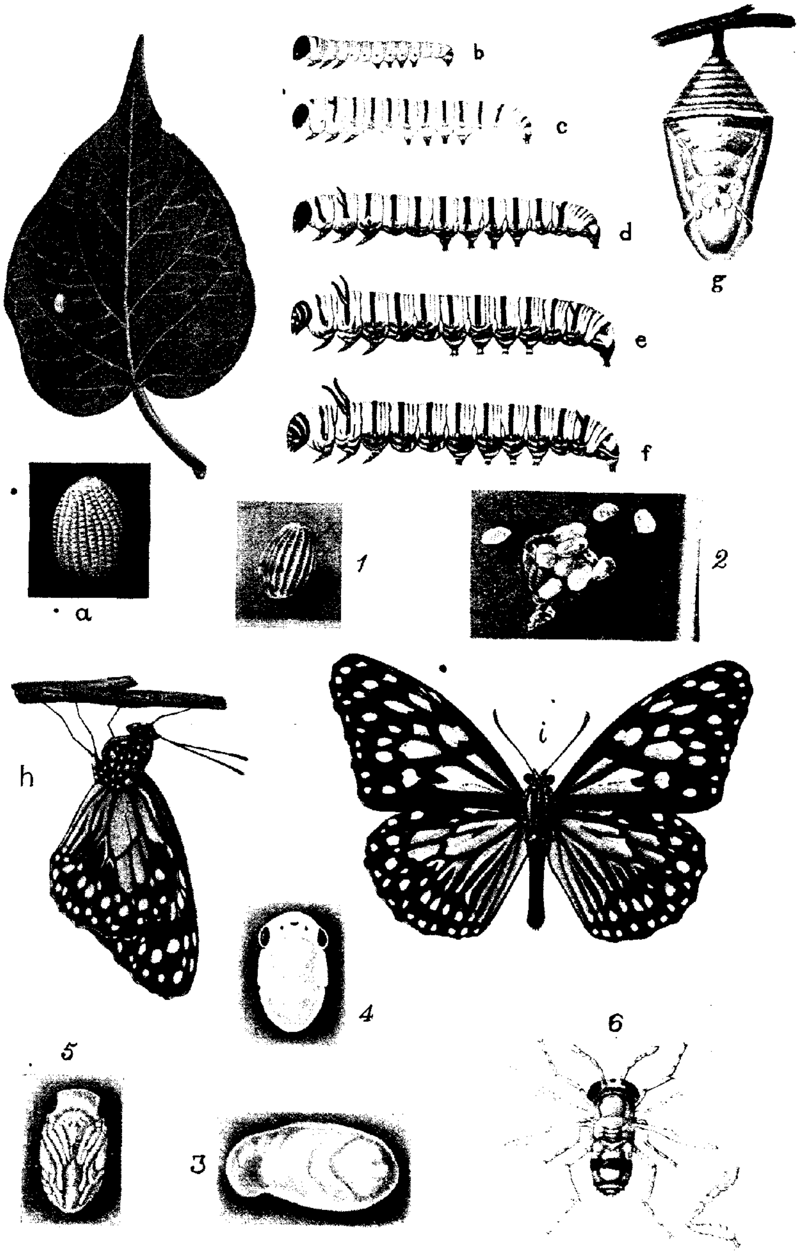
The newly hatched larva. (Description of first Instar.)

The newly hatched larva measures about 2·5 mm. long, 0·75 mm. broad across abdominal region. The shape is cylindrical, almost uniform in dimension throughout, tapering very slightly posteriorly. The head is larger than the prothoracic segment, roundish, deflexed, being held at right angles to the longitudinal axis of the body. The surface is shining, colour black, the dorsal surface having an inverted Y-shaped suture. The triangular area of the suture is lighter in colour. The clypeus also is lighter in colour, being whitish. The prothoracic segment has on each side of the pulsating middorsal line a greyish-blackish patch. The mesothorax has on either side of the middorsal line a small

EXPLANATION OF PLATE 26.

(*Danais limniace*).

a, Egg $\times$ 7.
b, Larva, first instar $\times$ 12.
c, ,, , second ,, $\times$ 10.
d, ,, , third ,, $\times$ 5
e, ,, , fourth ,, $\times$ 3.
f, ,, , fifth ,, $\times$ 2.
g, Pupa, dorsal view, $\times$ 2.
h, Butterfly with wings folded.
i, Butterfly, wings expanded, life-size.
1. A parasitized egg, magnified.
2, Egg opened to show the parasitic grubs.
3, The larva of the egg-parasite, magnified.
4, Pupa of the egg-parasite, dorsal view, $\times$ 40.
5. ,, ,, ,, ,, ,, ventral view.
6, Adult of the egg-parasite. $\times$ 40. The antenna is shown still more highly magnified.



DANAIS LIMNIACE.

fleshy knobby swelling. The thoracic legs are shining, well-developed, distinctly jointed and greyish-blackish coloured. The colour of the body including thoracic region is creamy white. The segments are not distinct being thrown into slight folds by the transverse creases which may be three or four in number. Minute black tubercles are arranged in a line transversely on the segments. The prolegs are five in number including anal claspers. The four abdominal ones are fleshy, cylindrical and have hooklets arranged on complete ringed soles. The colour on the outside is greyish-blackish. The anal claspers are greyish-blackish coloured and have the hooklets on nearly complete rings—a small outer part being uncovered by hooklets. The suranal area is greyish-blackish as also the fleshy portion below and at the sides of the anal orifice. The spiracles are roundish, blackish rimmed with clear centres. The colour ventrally is the same, *viz.*, creamy white. A few hours after hatching very light yellowish transverse bands develop from mesothorax to 8th abdominal segment which deepen to reddishness as the larva gets a day old.

Larva a day old. The size increases by 0·5 mm., being 3 mm. long. The ground colour is the same only light crimsonish transverse bands have developed from side to side on each segment beginning from the mesothorax down to the eighth abdominal segment. The crimsonish bands on the first and second abdominal segments encircle the entire segments. The fleshy pair of swellings on the mesothorax is crimsonish—a similar pair of minute swellings appears on the eighth abdominal segment, one on each subdorsal region. The ventral colouration is light yellowish.

The larva immediately after moulting feeds on the cast-skin; only the head moult remains behind.

Larva of Second Instar (after first moult). It measures about 6 mm. long and 1 mm. broad, the head is black, the clypeus is white. The prothoracic blackish patches are persistent. The mesothoracic filaments have developed and are crimson coloured. The mesothoracic filament is about 0·5 mm. long. The body colour is whitish. The transverse bands are reddish-crimson coloured and prominently developed from the mesothoracic to the eighth abdominal segment. The thoracic legs are black. The processes on the eighth segment have also developed but are much smaller in size. The abdominal prolegs are blackish on the outer side, the soles being fleshy and curved, having hooklets arranged in series on curved soles. The lateral spiracular region is yellowish. The suranal plate is shining black. The lower patches, which are in a group of three on each side of the anal orifice, are blackish. The ventral colouration is yellowish.

Larva of third Instar (after second moult). It measures generally about 9 mm. long and 2 mm. broad. Immediately after moulting the colour of the head is light grey which turns black gradually. The head now has a pair of white arcs on each cheek—one arc below the other and rather transversely directed, the upper arc is longer than the lower. The clypeus is white; faint blackish line starts from each spiracle upwards, towards the middle of the prothoracic segment over which the black patches are located. The transverse bands on the segments beginning from the mesothoracic down to the eighth abdominal segment have become deep crimson tending to blackishness. The mesothoracic filaments are about 1·5 mm. long. On the intersegmentals very thin transverse blackish colour develops. Anal orifice is surrounded by three black patches on each side. The ninth abdominal, being a very small segment, has one black transverse band on the middle of the back. The transverse bands are in the middle of the segments, preceded by a white broad area and followed by two transverse creases which throw the portion of the segment into folds. The spiracles are oval and black rimmed.

Larva of Fourth Instar (after third moult). The length is 17 mm. and 2·75 mm. broad. The head is black, shining, with three white distinct broad markings—a pair of arcs being on each cheek, the third one is common to both the pairs and is situated medianly in the triangular suture. The prothoracic black chitinized patches have grown in size nearly uniting in the middle and are situate on blackish lines which extend down to the spiracles. The mesothoracic filaments are 3·25 mm. and eighth abdominal filaments 1·5 mm. long, the first pair of filaments is black, the distal three-fourths of the interior and exterior sides of which are whitish, the processes on the eighth segment are whitish at the base on the exterior sides. The colour of the body is white, shining and smooth like white paint. The body is cylindrical and of nearly uniform dimensions. The dorso-lateral colour of the body is yellow whitish. The colour of the region below the spiracles is yellow. The thoracic legs are black. Thin transverse black bands have developed in the intersegmental region. The middle bands are black and thick followed by two creases and preceded by a white region, above which the intersegmental thin black band appears. The spiracles are oval black rimmed structures. The abdominal prolegs, which are four in number, are equally well developed. The colour is yellowish greenish on the inner side and black shiny and chitinized outwardly; above the curved sole a thin black line appears. The anal orifice is surrounded by three black shining patches. The suranal plate is black patched posteriorly—above this a white region appears and over it a black transverse line.

Larva of Fifth Instar. The length generally is 30 mm., breadth about 4 mm. The head is black with broad white arcs, a pair on each and a white triangular marking in the centre of the epicranial suture. The prothoracic band is like all other abdominal bands now, the dorsal patch being chitinized. The mesothoracic filaments are black with the three-fourths outer and inner distal sides white. Eighth abdominal process is half white both outwardly and inwardly from the base. The mesothoracic filaments are about 7 mm. long and the eighth abdominal process 3·25 mm. The thoracic legs are black and glossy. The cast skin in this instar was for the first time not eaten up. The body colour is white with sulphur yellow tinge. The bands are velvety-black, the intersegmental region of all the segments of the abdomen is black as well as the two black transverse creases. The lateral colour below the spiracles is yellow. The bases of the prolegs are mottled with specks of sulphur yellow and black. The distal bases of the prolegs are perfectly black and shining. The soles are fleshy and curved ; there is a black streak above the sole on the outer side. The spiracles are prominent, thick and black rimmed, very little space being left in the middle.

The larva after casting the fourth moult feeds for a day more when it increases further in size, about 38 mm. long and 5·5 mm. broad. On the second day after moulting it changes in colour. The head becomes bluish as well as the fleshy filaments on the mesothorax and the eighth segment. The prothorax and head become smaller owing to swelling up of the body. The larva grows passive and rests quietly on the surface on which it is going to pupate. On the third day the larva lets itself down vertically from the glass or wire-gauze cover or from a twig in nature by fastening its hind extremity with a few silken threads.

Pupa. The larva pupates generally on the fourth or fifth day by casting off its last moult. The pupa is suspended vertically head downwards from the point of attachment by its black cremaster whose hooked hairs are entangled in a pad of silk woven on the surface. The pupa measures about 18 mm. long including the cremaster which is itself about 2 mm. long. The pupa is about 9 mm. broad across the abdominal region along the white beaded rather serrated crescentic belt. It is 7·5 mm. broad in the middle and 7 mm. across the prothorax. The colour is light green, highly shining. The cremaster is black, strong and chitinized. The white band and spots are visible. A day after pupation the white belt on the dorsal half of the third segment has become shining silver white. More silvery spots have developed on the head and prothorax dorsally and laterally. The narrow ovalish spiracles are more clearly seen. The cremaster is ridged longitudinally. The arrangement and situation of the silver spots are as follows :—Two rather large spots on

each of the eyes. Two spots situated on each of the forewings anteriorly at the sides, *i.e.*, on a line drawn obliquely, joining the spots on the eyes and extended. One pair of small dots on the dorsal surface of the prothorax on each side of the middorsal line. One dot at the sides of the mesothorax just below the first pair of spiracles. One speck each, on the sides of the mesothorax at the lower angle, and a pair of broad spots one on each side of the middorsal line on the mesothorax. The metathorax has one dot on each side at the origin of the wing covers. The first abdominal segment has one small dot in the middle on the dorsal surface over the middorsal line. The second segment has three spots—two are situate below the spiracles at the sides and one medially. The third segment has got a silver half belt extending from spiracle to spiracle, thus covering about half the circumference. Below the spiracles there is a black elongate marking over the silvery belt on each side. A pair of small dots are situated at the termination of the silver belt at the sides. The spiracles are seen as narrow ovalish light coloured spots on the prothorax and the 2, 3, 4, 5, 6 and 7 abdominal segments. Thus seven spiracles are altogether visible. The 4, 5, 6, 7, 8 and 9 segments are much narrower in size. The pupa tapers or narrows down from the third segment which bulges out dorsally but tapers much less anteriorly up to the prominent mesothorax which is hunched dorsally. The ninth abdominal segment has got a pair of black warts ventrally below the cremaster, one on each side of the middorsal line.

Food-plants. In Pusa the larvae were found feeding on *Dregea volubilis* and *Marsdenia tenacissima*, respectively, in 1922 and 1909, both of which are Asclepiads. It may feed on other plants of the same family. *Hoya* is another food-plant recorded in Burma.

Distribution. Specimens of our collection were taken from the following places :—Pusa, April, May, June, July, September and November ; Belgaum ; Kashmir, November ; Coimbatore, August ; Ootacamund, December ; Kalyanipandal (Anamalais), January ; Sidapur (Coorg), April ; Coonoor (Nilgiris) ; Tatkon (Burma), September ; Bangalore, August. This species has a very wide range, writes Moore in his *Lep. Indica*, being found in the driest as well as the dampest localities. In the extreme north-west of our limit it was taken in Kashmir, at Khairabad in July, at Allahabad and Rawalpindi, in the Kangra district, at Ranibagh at the foot of the Kumaon Hills. In Nepal and in Sikkim in the north-east. It was also taken in the Terai in the Runjit valley. It is found throughout the Plains of N. India, being on the wing nearly all the year round, extending westward into Sindh. At Mhow it is very common from September to July and in the Deccan and Bombay it is common all the year round. Proceeding southward we have it from Mala-

bar, the Nilgiris, and in Travancore Mr. H. Fergusson states it is common from the foot of the hills to the summits, most abundant in November and December, common throughout February, only a few seen in March but again fairly common in the higher elevations in April and May. In Lower Bengal it was taken in Khurda in Orissa and in Calcutta it is plentiful all through the year and to be met with everywhere, particularly in gardens where it is almost the commonest insect seen. At Barrackpur it was found very common from March to October. North-eastward it is common in Cachar in April, May and June. At Sibsagar in Assam and in the Naga Hills. In Burma it is not uncommon in Rangoon and Toungu. In Tavoy in December and at Mergui in March. On the Irrawady river opposite Mandalay. On the Island of Ceylon it was obtained at Colombo in open or partially cultivated ground, being most common from October to December. In Nicobar it was obtained commonly on Nankawri, Kamorta and Kar Nicobar Isles as well as on Teressa and Bompka Islands.

Method of rearing.—The leaves on which the eggs were laid were collected and each kept in small crucibles (by cutting them in small sizes) on wet or moist pieces of blotting paper and covered over with round glass covers. Every day each cage was examined and the moult and the frass were completely removed. As the larvae began to grow they were individually transferred to larger glass cages with more fresh leaves of *Dregea volubilis*. After the fourth moult they were transferred to glass cylinders with wire gauze netted covers and supplied with a few dry sticks (for the butterfly to rest and expand its wings after emergence).

The larvae differ from those of *D. chrysippus* in colour markings and the possession by the latter of an extra pair of fleshy filaments on the second abdominal segment.

Enemies.—From one of the grown-up larvae that was collected from the field on 19th June 1922, one Tachinid larva came out by the posterior end. The caterpillar was about to pupate, as it was casting off its last moult, when the parasitic maggot emerged from the body. The maggot was supplied with a little dry earth. It pupated on 22nd June 1922 and the fly emerged on 29th June 1922.

II. The eggs of the butterfly were extensively parasitized by small Chalcidid grubs. Forty eggs were collected on 27th June 1922 and out of them twenty-three eggs were parasitized. Parasitic grubs pupated on 30th June and 3rd July 1922 and flies emerged on 3rd and 6th July 1922 respectively. Out of thirty-eight eggs collected on 8th July 1922, about twelve were found parasitized and out of forty-eight eggs collected on 1st July 1922, twenty-one were parasitized on 3rd July 1922. The grubs were in every case found inside the eggs of *D. limniace* laid on leaves.

As the parasitic grubs developed inside the egg-shell, the outer colouration of the butterfly egg changed. On the creamy white colour of the egg develops the blackish specks which give the egg a mottled appearance. It is this outer blackish colouration of the egg-shell that points to the presence of parasites. Moreover, if a parasitized egg is held against the light and looked at through a powerful lens, white roundish bodies will be visible through the egg-shell. When the grubs have pupated inside the shell, the red eyes of the pupae also can be seen through it. Several eggs were dissected to find out the number of parasitic grubs in each. The number varied between the minimum of five and the maximum of eleven. Seven, nine, and ten grubs were more commonly found in each egg. Pupation of the grubs takes place within the shell—the pupae remain crowded together. Emergence takes place by one of the flies biting a small hole at the side of the egg-shell. The newly emerged flies then come out one by one through the same hole. The grub measures slightly less than 0·55 mm. long and 0·3 mm. broad. The shape is oval, bulging a little posteriorly. The colour is shining transparent glassy white. Annulation of the body is quite meagre. The posterior or swollen portion contains a beaded mass of sulphur yellow fatty tissue which shows itself through the transparent skin of the grub. No other structure could be made out except a pair of spiracle-like openings situated at the apex of the anterior end of the grub. The openings were only half rimmed and light brown coloured. The grubs pupate without forming any sort of cocoon. The fresh pupa is transparent glassy whitish with the abdomen swollen and tapering towards the anterior end. The faint pinkish spot at each side of the head is the developing eye which gradually deepens to reddish crimson colour as the pupa advances in age. Later on, about the second day after pupation, minute pinkish dots, three in number, appear on the dorsal surface of the head between the two eyes. These are the ocelli. The colour of the pupa deepens with age to very pale yellowishness. The pupa is shining and measures about 0·5 mm. long and 0·25 mm. broad. On the third day of pupation the eyes and ocelli become deeper, the mandibles become brown, the last joint of antennae, which lies between the first and second pair of legs, becomes light sooty grey. The wings also become grey. On the dorsal surface of the bulging abdomen sooty transverse bands appear, about three to five in number, on yellowish ground colour. The legs, wings and antennae are folded ventro-laterally and symmetrically so that the middle portion of the abdomen is free. In the thoracic region the broad coxae are visible. The fly measures about ·43 mm. along its longitudinal axis.

Summary. In the first week of May 1922, eggs of *Danais limniace* were collected and reared. The number of eggs that could be laid by a

single female Butterfly was not determined . In one case an egg was actually seen laid on the leaf in the field and it was brought in and kept for hatching of the larva. The period of incubation is three days, as could be noted from this single instance. It is generally three days in the case of the allied species *D. chrysippus* (*vide* Memoir by C. C. Ghosh). The number of moults is four. The skin is shed on the third day after each moult generally and the larva feeds on the shed skin, leaving behind the head moult up to the third moult. Pupation takes place on the fourth day after the last moult, on the leaf or twigs. The pupa is light green with silver belt and silver spots --in other references the spots are described as golden. The Butterfly emerges by bursting the lower or head end of the pupa and hangs on the empty pupa case with crumpled wings and short thick abdomen. In about half-an-hour the wings expand and harden, the abdomen lengthens. The period of life-cycle, in rather hot weather prevailing in May and June, is generally twenty days from egg to adult. The butterfly could remain alive for three days without any food. The egg period is three days, larval period ten days and pupal period seven days. The fleshy filaments on the mesothorax and the eighth abdominal segments are characteristic and the eighth abdominal filaments are generally half as long as the meso-filaments. In the case of the larva of the third instar the head has only two white markings, in that of the fourth instar three white markings.

Egg collected.	Larva hatched measurements.	First moult date with measurements.	Second moult date with measurements.	Third moult date with measurements.	Fourth moult date with measurements.	Fifth moult pupation date.	Emergence of Butterfly date.	REMARKS.
19-6-22.	19-6-22.	21-6-22.	23-6-22. L=9. B=1·75. M.G.=1·25.	25-6-22. L=16. B=2·25. M.F.= 2·75. 8th F=1·5.	28-6-22. L=29. B=4. M.F.=4. 8th F=2.	1-7-22.	8-7-22.	19 days life-cycle from the day the egg was collected.
		22-6-22 L=0 mm. B=1·5 mm.		27-6-22. L=24. B= 3·5.	30-6-22. Colour changed to a bluish here. L=36 mm. B=6 mm.			
19-6-22.	20-6-22.	23-6-22. L=7 mm. B=1·5. M.F=1 mm.	25-6-22. L=11 mm. B=2 mm. M.F=1·75 mm.	27-6-22. L=18 mm. B=3. M.F=3.5. 8th F=1·5.	29-6-22. L=30. B=5·5. M.F=7 8th F=3·25. 30-6-22. Larva acquired a bluish tinge.	2-7-22.	9-7-22.	20 days life-cycle from the day the egg was collected.
	20-6-22. Larva collected.			22-6-22. L=19. B=2·5. M.F=4 mm.	24-6-22. 26-6-22 L=28. 27-6-22 L=37. B=4·5. 29-6-22 acquired a bluish tinge.	30-6-22.	7-7-22.	17 days life-cycle from the larval stage.
28-6-22.	29-6-22.	1-7-22. L=6 mm.	3-7-22. L=11 mm. B=2 mm. M.F=1·5	4-7-22. L=22 mm. B=4 mm. M.F=4 mm. 8th F=2 mm.	6-7-22. L=23. B=4 mm. M. F.·6 mm. 8th F=3·25 9-7-22. L=38 mm. B=6 mm. M.F=6 mm.	10-7-22.	17-7-22.	19 days life-cycle from the day the egg was collected.
		2-7-22. L=8 mm. B=1·75 mm.						
19-6-22.	21-6-22.	Larvae were not reared further.				10-7-22.	15-7-22.	Five days pupal period.
8-7-22	11-7-22.					15-7-22.	22-7-22.	Seven days pupal period.
12-7-22	14-7-22.					1-7-22.	7-7-22.	Six days pupal period.
						22-6-22.	29-6-22.	Seven days pupal period.

NOTE.— The measures are all very approximate. Abbreviations :—

L.—Length of body from head to the anal claspers in millimetres.
B.—Breadth across abdominal region (generally the 4th segment).

M.F.—Mesothoracic filament (Length of).
8th F.—8th abdominal filament (Length of).

43.—THE EVOLUTION OF THE FACULTY OF COMMUNICATION IN ANTS.

By Major R. W. G. HINGSTON, I.M.S., M.C., M.B., F.R.G.S., F.Z.S.

It is impossible to observe ants for any length of time without realizing the fact that they communicate with one another, that a single worker can transfer information and can call a number of comrades to its aid. My object in this paper is to analyze this instinct, to suggest the manner in which it seems to have originated and the path along which it has evolved.

Let us first consider it in the finished state. We can observe it thus in many kinds of ants. *Phidole indica*, for example, habitually communicates, a worker invariably running back for assistance whenever a capture is made. *Camponotus compressus* has a similar power, but makes use of it only on special occasions, such as when it is unable to shift its load. The same faculty is possessed by *Iridomyrmex anceps*, but, since this ant lives largely on the excretions of Aphides, the call for assistance is only occasionally required.

Phidole indica will best exemplify the act. As soon as a worker discovers an insect, its first act is to make a superficial exploration, then, finding the insect too heavy for transportation, it hastens at full speed back to the nest. It plunges straight into the entrance, and in a few seconds after it has disappeared, a dense army of excited workers comes pouring hurriedly out through the gate. Without the slightest hesitation they hasten outwards, follow back along the track of the discovering worker, and, as a rule without encountering any special difficulty, come on the treasure which the first worker had found.

Such is the occurrence as we ordinarily see it, but there are certain details with respect to its production which demand our special note. The first is that the worker which brings back the news does not act as a leader to the issuing army, for the army will often advance in front of the discoverer, or, if the discoverer is captured at the moment of its exit, the army will still be able to find the place. The second point is that the army, in its outward progress, retraces the track of the discovering ant; and the third detail is that the army recognizes this track by means of the faculty of smell. In this act we see the height of the communicating efficiency. A worker arrives, proclaims the news, and, without the necessity of its further co-operation, the army secures the spoil.

Bearing in mind this manifestation of the instinct in *Phidole*, let us turn now to some other species for instruction in the manner by which it has evolved.

The first species to consider is *Camponotus sericeus.* It possesses no such elaborate power of calling out an army of workers to its aid. But it often displays a more instructive performance, which illustrates, I believe, the primitive foundation on which this faculty of communication is based. It is a common occurrence to see a pair of workers making their exit from this ant's nest. One follows immediately on the other, and away they go in the direction of a tree. The first is clearly the leader of the pair; the second is being led. There is no possibility of doubt about this. They never change their respective positions; the second worker keeps close up to and immediately behind the first. It scarcely ever falls more than half an inch behind, and it follows exactly in the footsteps of its leader through every turn and inclination that occurs. The pair thus advances over the soil with a peculiar jerky gait. The one in rear continually makes little forward rushes so as to touch the tail of the one in front. By so doing it knows that it is on the right track and that it has not lost touch with the leader in advance. The leader too assists in maintaining connection. It moves at less than its ordinary speed and in a rhythmical succession of jerks. Its tardiness prevents it from running away from its follower, and the jerks result in a synchronization of movement with the forward rushes which the other makes in order to touch its tail. The maintenance of these repeated tactile communications is often a difficult feat. This is specially so when the road is obstructed. The second of the two ants may then fall an inch or so behind, and, as a consequence, tactile communication is lost. It runs about in every direction, searching here and there amongst the twigs and leaves; its steady and deliberate advance ceases as it eagerly seeks for the leader it has lost. The leader too is aware of the separation; it no longer feels the repeated touches on its rear, and consequently it knows that its partner is astray. It also takes steps to restore the union. But it does not rush hurriedly about like its companion; it adopts a quicter plan. It remains absolutely motionless in its place, that is, at the spot where the separation occurred. The lost ant, having searched all round about, at length comes back to the original place. There it finds the leader awaiting its return. Their antennae touch; they recognize one another; the lost ant falls back into its old position; the leader again takes up the advance with the second following as before.

In this we have the simplest form of communication and the most rudimentary example of a call for aid. It is simple in the first place

owing to the number engaged ; it is a case of just one ant bringing forth another ; there is no attempt at a straggling troop, still less at a multitudinous swarm. In the second place it displays only the weakest of links ; if the follower happens to fall only an inch behind its leader, then the connecting bond between the two is severed and the follower can no longer pursue its course. In the third place we notice the mechanism of communication ; it is the simplest and most primitive of all possible kinds, merely the ordinary and intelligible instrumentality of touch. Lastly, we must observe, so undeveloped is the instinct, that the leader has frequently to assist the progress by waiting until its follower, which often goes astray, has regained its previous position in rear.

Let us now turn to another species, *Camponotus paria*, in which we can observe this communicating faculty developed to a somewhat higher degree. As in the case of *Camponotus sericeus*, one ant frequently leads out a comrade, usually in the direction of a neighbouring tree. But there are certain differences in their manner of advance, minute details in one respect, yet of considerable importance to us. The second ant does not keep so very close behind its leader ; it often falls two or three inches in rear, yet it does not lose its way. Nor is a continuous succession of touches necessary in order to enable it to keep its place. Occasionally, and more especially in difficult situations, it does run forward on its leader's tail, but I often see them travel for a number of yards without any such tactile communication taking place. Nor does the leader assist in the maintenance of the union. It does not adopt that jerky method of progression since the synchronization is not required. If the follower goes astray, or if it be removed, the leader does not halt, as does *Camponotus sericeus*, but continues in its steady course.

Here, therefore, we find a definite advance in the instinct, a step towards that higher and more elaborate organization which we observe when the swarm is called forth. But again we note that only two ants are employed, though they are linked in a more efficient way. The slightest disconnection no longer severs them ; the repetition of tactile communications is unnecesary, and the whole responsibility now falls on the follower since the leader has abandoned that simple habit of waiting whenever a break occurs. This surely marks a decided advance on the primitive mode of leadership by touch.

Now, since the instinct has reached that stage of development when tactile communication is no longer required, it might be thought that the second ant follows the first by employing its sense of sight. Does it just watch the tail of its leader and follow where the latter goes ? This certainly is not the case. As the pair advances through the jungle

of leaves, it often enters some difficult place. The second ant finds it hard to maintain its position; as a result it falls a few inches in rear while the leader turns in and out amongst the leaves and is lost to the follower's view. But this does not break the connecting link; the second ant follows on the track of the first even though its leader is out of sight. Again I observe that the follower sometimes goes astray. The leader continues; it probably does not realize that the union is broken, since there is no application of touches to its posterior such as *Camponotus sericeus* requires in order to keep the union intact. The follower, by its own efforts, must regain its position, though in a minute the leader may be a foot in advance. It, therefore, rapidly hurries about searching round the point at which it lost touch. For a little while it is confused and cannot find its bearings, then it comes upon some part of the track along which its leader has advanced. Immediately it is satisfied and reassured. The leader may have passed far beyond its range of vision, perhaps even turned round the edge of the tree, yet the follower immediately appreciates its bearings and takes up its leader's track. It moves so hurriedly that it catches up its leader and the dual progress is resumed. There can be no necessity to elaborate further. The primitive tactile communication has been abandoned; it has been replaced by the faculty of smell.

This conclusion is easily confirmed. The leader and its follower have reached the tree and without further difficulty are ascending the bark. I draw my finger across the bark between them, with the intention of disturbing the scent. Some slight confusion is the immediate result. The leader is unaffected and continues its course, but the follower hesitates when it reaches my line; clearly I have in some way obstructed its progress, nevertheless it soon makes its way across and resume its journey as before. I then draw three moist fingers across the track. Considerable excitement and perplexity now follow, and only after a search in every direction does the follower circumvent the invisible obstruction and in this manner find its way round. Tactile communication has absolutely vanished. It served as a guide in the rudimentary stages, but the olfactory sense has now been introduced as the means by which one ant leads another from the nest.

Let us turn now to a third species, the common black ant, or *Camponotus compressus*, and we will see how this faculty of communication has advanced another stage. I fix a locust to the trunk of a tree at about five feet distance from one of their nests. A soldier soon finds it, tries hard to remove it, but, after struggling in vain for about ten minutes, hastens back to the formicary for aid. It remains inside for a minute or two, and when it emerges we see a troop of workers following closely

in its train. Without hesitation it makes back to the locust. Immediately in its rear is the rescuing troop. They are probably about eight to ten in number and both soldiers and smaller workers are represented in the file. The ants, thus formed into a compact party, advance, one close behind the other, often in a single line. It is a steady, regular and deliberate procession; the discoverer leads, the troop follows, and they all have a clear purpose in view.

Here, therefore, we see a further step in the instinct. A single follower has been replaced by a group of workers. It is an advance in degree rather than in kind, for each one in the line follows the one in front by employing its sense of smell. In a general way also the instinct has improved. The act is now more rapid and performed with more precision; moreover the connecting link is more perfect and the followers are less likely to lose their way. I may add that *Camponotus paria* sometimes adopts this more elaborate performance of calling forth a troop.

Camponotus compressus, though it shows a decided advance, is yet far from possessing the communicating instinct in its fully developed state. It has not attained the efficiency of *Phidole,* partly because of the smallness of the troop, but still more because the troop is dependent on the discoverer, and, without its leadership, is almost sure to go astray. In *Phidole* the army is independent of a leader and can come by itself to the desired place.

But there are certain facts in the operation of *Camponotus compressus* which suggest a progress to a higher stage, for example, the discovering ant, when hurrying back for aid, will frequently meet another worker on the way to which it will communicate the news. The second worker then, if the distance be not too great, will turn about and retrace the track of the discoverer and may often by its own efforts find the treasure without any further guide. This gives us the clue to the next stage in the development. The second worker follows back on the scent of the first worker and thus, independent of any leadership, comes by itself to the place.

All that is now needed is improvement and refinement in order to reach the perfect state. Advance the capcaity of *Camponotus compressus*; improve its sense of individual recognition; intensify its wonderful faculty of smell; develop its power of retracing the track beyond the extent of a few inches to the full distance between the treasure and the nest; at the same time increase its enthusiasm and the numbers that pervade the issuing throng, and the result is that perfection in the communicating instinct which is ordinarily observed in *Phidole* ants. There is no introduction of any new principle; it is merely by

improving the machinery of *Camponotus* that the high efficiency of *Phidole* is reached. And *Phidole* seems to have attained supreme perfection. For the discoverer just rushes into the nest; in an instant out comes the teeming legion which is standing in readiness within the gate, and away they break at the utmost speed, skilfully pursuing the scent of the discoverer whose services are no longer required.

Thus, what at first sight seems an act of considerable complexity can be reduced to very simple terms. When we commence to investigate the *Phidole* army we seem lost in a confusion of excited ants. We marvel at the manner in which they suddenly appear, the enthusiastic haste with which they hurry to the spot, their unerring and apparently unguided progress over an unknown road. It all seems a kind of miraculous occurrence as though they moved by some supernatural sway. The fact is that we are lost in the perfection of the operation. The individual communication is so rapidly performed, the olfactory sense is so inconceivably acute, that our minds are blinded by its wonderful efficiency and we are unable to see the light. But these species under discussion have aided our vision. They have enabled us to understand steps in the process and to elucidate the evolution of the communicating power.

The stages in the process may be summarized thus. It originated in one ant leading out another and maintaining connection by the very simple process of the second ant repeatedly touching the first. But this, being a tedious mode of progression and liable at any moment to result in a break, was far too inefficient for the requirements of the ants and must soon have begun to improve. The follower then commenced to use its sense of smell, and, as a consequence, the tactile communication became less important and therefore began to disappear. At the same time the leader ceased to render assistance, since the follower was now able to retain its position by the use of the more subtle sense. Additional workers now began to join in the procession, each one following on the one in front under the guidance of its olfactory sense. But still they remained dependent on their leader for conducting them along the right road. As the olfactory faculty continued to improve, their reliance on a leader became proportionately less. Then the followers began to move on their own accord, provided that they were supplied with the line of scent. Their leader was still of some value to them; they frequently communicated with it to gain reassurance and without it they still often went astray. One further advance in the olfactory sense brought them to the most developed state. They had now reached the condition of the *Phidole* ants; the few followers had grown into a multitudinous army which was quite independent

of any leader and needed only a momentary contract with a worker to enable it to follow on the line of its scent.

Such I believe to be the origination and the mode of evolution of an instinct which, in its finished complexity, defies our attempts to understand. A tactile communication was its rudimentary beginning; its progress depended on successive refinements in the ordinary sense of smell.

Our thanks are due to Major Hingston for the interesting paper he has read. This is an example of the extraordinarily interesting observations which can be made by any observer anywhere in India. Such observations help on the cause of Entomology as they interest not only the Entomologists but also the General Public.

Is there any reason to suppose there is a connection between the stage of development of the faculty of communication and phylogenetic position? Does one see in *Phidole* any evidence of the older individuals teaching the young?

Personally, I think not. This would imply education which itself implies intelligence whereas I believe the ants to possess at most only the rudiments of intelligence; and that their behaviour is mainly ascribable to instinct.

44.—THE LIFE-HISTORY OF A TINGID BUG, *MONANTHIA GLOBULIFERA.*

By M. O. T. Iyengar, B.A., F.Z.S., *Entomologist to the Dept. of Public Health, Bengal.*

(Plates 27-28.)

Monanthia globulifera Walk* has been observed by the author to occur very commonly on the *Tulsi* plant, *Ocimum sanctum* (Labiatae), causing considerable damage. As a result of the attack, curling and drying up of the leaf-tips as well as shedding of the leaves occur. The plants present a sickly appearance and the production of inflorescences is much suppressed. This bug has been recorded from other plants belonging to the family *Labiatae*, like the garden *Coleus* and the English Sage.

The life-history of this bug is interesting from the fact that the larval and pupal stages exhibit a great deal of difference from the adult form as will be seen from the following description and figures.

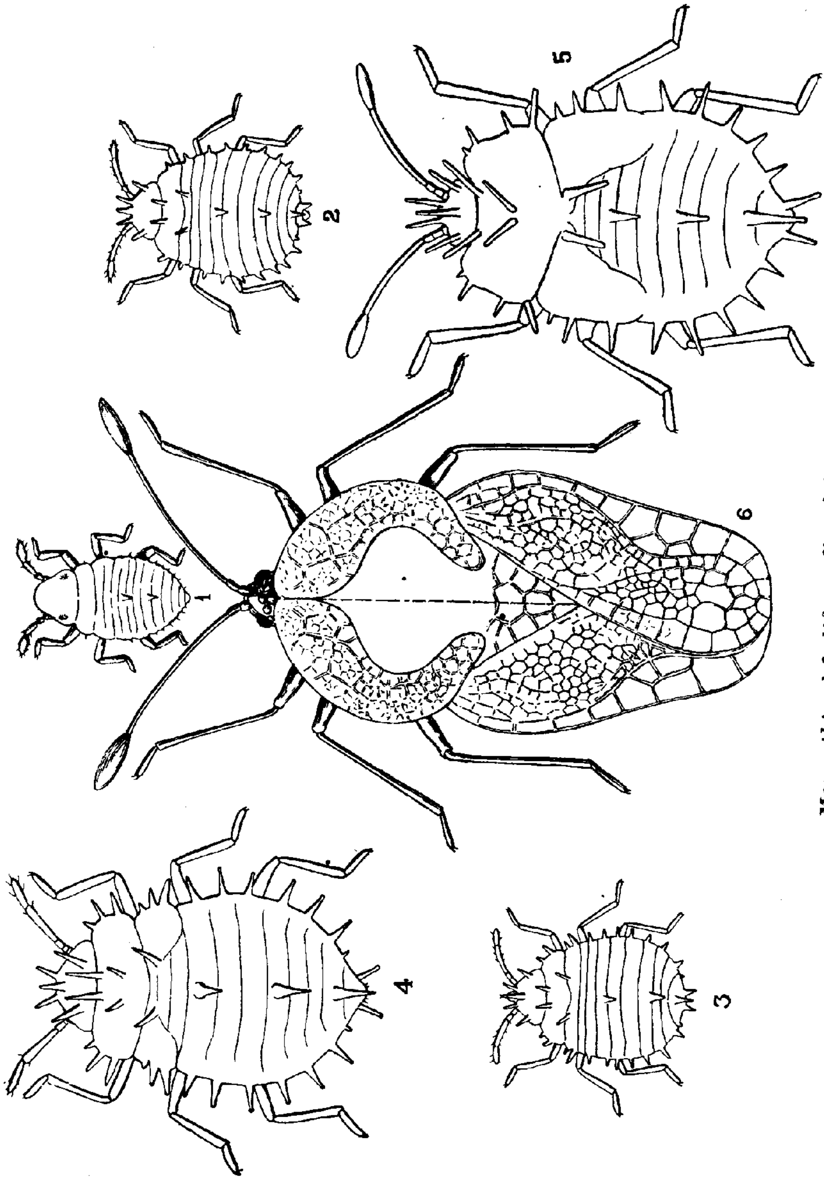
Egg.—The eggs of these insects have not so far been observed.

First Instar.—The first stage larva is very small, not easily made out with the naked eye, the average size being 0·6 mm. long and 0·34 mm. at its broadest point. The eyes are represented by ocelli. Antenna 0·24 mm. long, the apical segment clubbed and the pre-apical segment nearly as long as the apical one. Glandular hairs are found on the dorsum of the body, more especially projecting beyond the edge of the abdomen. These consist of a short root, a long hair the tip of which is enlarged and glandular. These glandular hairs are present on the head, thorax and abdomen but are mainly to be found at the lateral edges of the abdominal tergites. Some of these glands are much enlarged, while others are in a collapsed state apparently after the discharge of its contents. A few glandular hairs are present on the antennae as also on the legs.

The thoracic and abdominal segments are clearly marked out. The surface of the body is smooth without any bristles or spines. The tip of the abdomen is acute and turned downwards ventrally. Dorsally on the 2nd and 5th abdominal segments, short papillae are seen on the median line.

Second Instar.—In the second instar, the glandular hairs have become very few. A row of thick chitinous processes start from the lateral edges of the tergites of thorax and abdomen, one on each segment on either

* Determined by Mr. W. E. China



Monanthia globulifera. Stages in the life-history.
1, Nymph, first instar ; 2, Second instar ; 3, Third instar ; 4, Fourth instar ; 5, Fifth instar ; 6, Adult. All figures are × 10.

side. These processes have rings of small spines on them. The average length of the body is 0·7 mm., breadth 0· 6 mm. and the length of the antenna 0·26 mm. The terminal segment of the antenna is not markedly clavate; the pre-apical segment has elongated somewhat and is in this stage much longer than the apical segment. It is as much as 1½ times the apical one. The head has two paired lateral processes and one median unpaired one. The pro- and meso-thoracic segments are provided with lateral processes while the metathorax has none. Medially, the pro- and meso-thoracic segments have paired dorsal processes, not found on the metathorax. On the abdomen, all the segments have paired lateral processes; the processes on the 8th segment are small. Median unpaired processes occur on the abdomen dorsally and these are found on the 2nd, 5th and 8th segments. Besides these thick lateral processes, others longer and thinner could be made out scattered over the dorsum of the body. The entire body is covered over with very minute spines visible under the microscope. Wing rudiments are not visible.

Third Instar.—In the third stage, the insect is a very black spiny creature about 0·8 mm. long and 0·5 mm. broad. Its antenna measures nearly 0·4 mm. long. The apical segment of the antenna is distinctly clubbed; the basal segments are thin; the pre-apical segment has elongated more than in the previous instar and is nearly twice as long as the apical segments. The numerous spiny processes are arranged over the dorsum of the body, the distribution being as follows. On the head are two processes anteriorly and just behind these is a long median one. Posterior to the eye is another pair of processes projecting forwards and outwards. On the thorax, the first two segments have each two processes on either side and the third segment has none; the anterior of each of these is smaller than the posterior one. Median paired processes also occur, one pair on each of the pro-and meso-thoracic segments. On the abdomen are found the lateral processes on all segments, those on the 8th segment being very small. In addition to these, median unpaired processes occur on the 2nd, 5th and 8th segments of the abdomen.

The thorax has no flat expansions as occur in the next instar and the outline of the thorax does not extend beyond the outline of the abdomen. The body has very minute spicules dorsally. The eye is quite prominent and protrudes beyond the profile of the head. A few facets are seen.

Fourth Instar.—This stage is similar to the third stage, but the dorsal thoracic lateral wing-like expansions are very prominent. The body measures 1·15 mm. long and 0·7 mm. broad. The antenna is 0·5 mm. long. The terminal segment is distinctly club-shaped; the subterminal

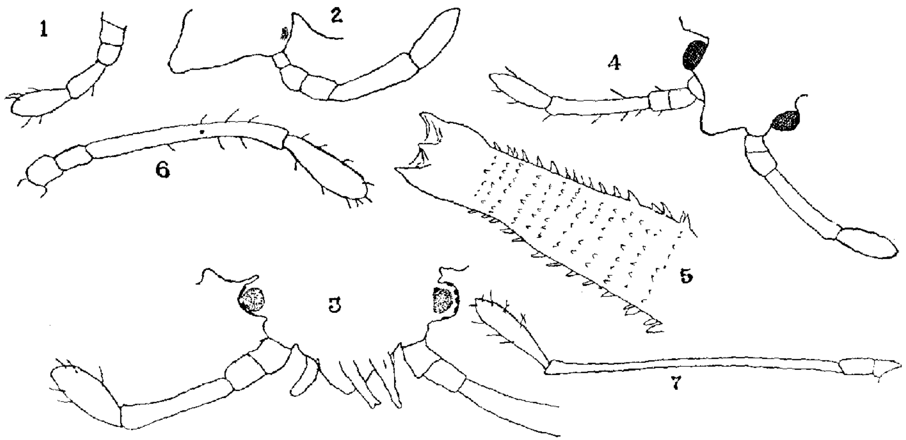
segment is twice as long as the terminal one. The eyes are very projecting and the facts are fully formed. The head has two pairs of spiny processes, one pair projecting forwards over the head and the other projecting over the eyes. In between the anterior pair is a median unpaired one. The first two segments of the thorax have flat wing-like expansions of the chitin dorsally. They are provided with three lateral processes and a pair of median ones. A small rudiment of the wing is visible projecting from the mesothorax over the metathoracic segment. The metathoracic segment has no lateral processes and is greatly covered over by the mesothorax. On the abdomen, the three unpaired median processes are present as in the third instar. The 1st segment of the abdomen has no lateral process and is covered by the wing-rudiments. The lateral processes are well-developed on all the others except on the 8th segment.

Fifth Instar.—This stage is bigger than the previous one and measures 1·8 mm. in length and 1·1 mm. in breadth. The antenna is 0·85 mm. long; the apical segment is clubbed and the pre-apical segment is twice as long as the apical one. The processes on the head are similar to those found on the previous instar. The eyes are well-developed and project prominently. The thorax is covered over with one dorsal plate with wing-like expansions laterally. This is the prothoracic plate; there are two pairs of spiny processes on it dorsally and four pairs of lateral processes. It completely covers the mesothoracic segment anteriorly. The mesothoracic segment has a pair of median processes and three pairs of lateral ones. The rudiments of both the anterior and posterior wings are clearly to be seen and extend as far down as the fourth segment of the abdomen. As in the previous instars the abdomen has three unpaired processes medially on the 2nd, 5th and the 8th segments. The lateral processes on the 4th to 9th segments are prominently seen. Those on segments 1 to 3 are apparently absent.

Adult Stage.—In the adult insect, all the spiny processes, which were so characteristic of the previous stages, totally disappear. Neither these nor the glandular hairs are to be seen. From its appearance the adult appears to be quite a different creature from the immature forms.

The head is small with the 4-jointed proboscis bent under and carried ventrally. At the base of the proboscis are two flat plates starting from the head hanging over the proboscis. These plates are cellular in design. The antenna is 0·9 mm. long. The basal three segments are short and thick, the 4th segment is long and thin and as much as three times the length of the apical segment.

PLATE 28



Details of stages of *Monanthia globulifera*. 1, Antenna of nymph, first instar; 2, Antenna of nymph, second instar; 3, Head and Antennæ of nymph, third instar; 4, Head and Antennæ of nymph, fourth instar; 5, Spiny process, fourth instar; 6, Antenna of nymph, fifth instar; 7, Antenna of adult.

The thorax is peculiar in the presence of the hollow globular outgrowths which are trelliced in design and curve inwards as hollow globules from the outer margin where they start. These are free medially. Just underneath these are thin rib-like strands which are covered with long hairs. These outgrowths are prothoracic in origin. The anterior pair of wings are thick, hyaline and highly cellular in structure; in the middle of each wing are two raised areas. The second pair of wings are completely covered over by the first pair while the insect is at rest. These wings are very membranous, transparent and very feebly veined.

Although in some years Tingids cause some damage, they are not generally very destructive.

I attach no economic importance to this species. The point of my paper is to draw attention to the variation in structure in the different nymphal stages.

45.—OBSERVATIONS ON SOME RHYNCHOTA FROM NORTHERN INDIA.

By Rai Bahadur C. S. Misra, B.A., *First Assistant to the Imperial Entomologist.*

(Plates 29-30.)

The acccompanying observations were begun early in 1908 with a view to record the habits, food-plants, seasonal appearances, etc., of as many local species as were come across during the fieldwork. Owing to other calls, it has not been possible for me either to enlarge or complete the observations, but they are given here as recorded in my note books with the hope that some other fellow-worker with more time at his disposal may see his way either to amplify or complete them. In some cases the notes are very short, but even such notes at times go a long way in substantiating observations made by other observers similarly circumstanced. Besides these considerations, the presence of kala-azar in and in the neighbourhood of Pusa induced me to collect and make observations on such sucking insects as entered houses at Pusa and to examine their contents in sections and then to forward these to the proper authorities for further examination and verification. I have been particularly observing the occurrence of *Triatoma rubrofasciata* in houses at Pusa. All that I have been able to observe regarding this insect is that adults come to light and especially in the early morning hours between one and four o'clock. I have never come across the nymph of this species of Reduviid, excepting one I chanced to get recently on 9th February 1923, when it settled on me and could only be extricated from my clothes w.th some difficulty. When dissected by the Imperial Agricultural Bacteriologist it was found to contain mammalian blood and sections of its hind-gut revealed the presence of a large number of flagellates in it.

Pentatomidæ.

Eusarcocoris dubius, Dall.

During the middle of June 1911, numerous adult bugs were found on maize tassels at Pusa along with *Megacoelum stramineum*, with the result that the male flowers fell off in large numbers, thus restricting fertilization of the cobs. Later on in some fields, the adults were found on the maize seeds as they were setting.

Amyotea (*Asopus*) *malabaricus*, Fabr.

On the 16th December 1912, an adult bug was observed to have transfixed to death an adult white-weevil, *Myllocerus* 11-*pustulatus* (*maculosus*), on a cotton-plant at Pusa. The beetle, when seen transfixed to the rostral setae of the adult bug was alive but made no efforts to escape its enemy. The bug had thrust its rostral setae on the dorsum of the beetle between the base of the metathorax and the elytra, and continued sucking the body-juice until the beetle was completely sucked dry, when it withdrew its rostral setae, leaving its victim dead on the leaf below. Whilst feeding, the victim was raised at the point of the rostral setae, and was held up in this position at times for a few seconds.

Aspongopus brunneus, Thunb.

During 1912 and 1916, the bugs were bad at Pusa on pumpkin plants. The eggs, nymphs and imagines were present in such large numbers that a row of twelve plants appeared completely blasted by the end of July 1916. The leaves turned brown and ultimately died and the whole plot presented a sickly appearance. The adults are very sluggish in their movements and the female may be seen depositing eggs in rows on the leaves as well as on the leafstalks. The eggs are laid in clusters. The nymph, when about to hatch out, punctures a portion of the egg-shell and comes out. In the early stages they are gregarious and may be seen clustering in numbers round leafstalks and stems. They emit a pungent smell which is felt in the infested plots.

Halys dentatus, Fabr.

Eggs, nymphs and imagines are present on *Albezzia lebbek* trees at Pusa. The eggs are laid in clusters of thirteen to seventeen on the bark of stems. Each egg is 1·5 mm. long and 1·00 mm. broad, and is flattened at the top. The nymph when about to come out pushes off the egg-cap and remains resting for some time either on or near the egg-mass. Its colour then is dark-grey in keeping with the colour of *Albizzia* stems and as such it is not detected easily. During a heavy fall of rain the nymphs, as well as the adults, were seen to hide in the crevices of the bark. They seem to subsist on the scanty nourishment they can get out of the stems and tender shoots.

Chilocoris nitidus, Mayr.

The nymphs have been seen at Pusa on the roots of *Dub* grass (*Cynodon dactylon*). They are pinkish-brown in colour and have been

observed to move about freely underground, though not much below the surface of the ground. A colony of six to eleven may be seen on the roots of a single plant. They are active and with the least disturbance run about in their subterranean galleries which are not very long. The final moult takes place underground and the adult comes out on the surface to feed.

COREIDÆ.

Clavigralla gibbosa, Spin.

The adults remain congregated on the tender, as well as the mature, *Tur* (*Cajanus indicus*) pods. All the stages of the bug are passed on *Tur* and the nymphs prefer to feed on the tender pods. The imagines have been observed to be especially active during the hottest part of the day. The eggs are laid in clusters on the leaves as well as the beans. The number of eggs in clusters has been found to vary from five to thirteen. Each egg is oval, flattened at top and greyish-ochraceous in colour. These are at times parasitized heavily by a Chalcidid parasite and the parasitized eggs turn dark grey in colour. The parasite comes out after drilling a circular hole on the egg-capsule ; the amount of parasitization has been observed to be the greatest during April and May. It has also been reported from Nagpur on *Tur* (*C. indicus*).

Homoeocerus inornatus. Stäl.

The nymphs, as well as the adults, are found in numbers on *Dalbergia sissoo* seedlings. The colour of the nymph is in keeping with the colour of the leaves on which it feeds. In the nymphs the remarkable thing is the presence of the stink-glands on the dorsum of the abdomen. If these are lightly tapped with a stick, they exude a droplet of clear fluid which volatilizes as soon as it comes in contact with the air. It is for this reason that a strong, pungent smell is felt to prevail near *sissoo* seedlings where these nymphs, as well as adults, seem to be feeding in numbers. On account of their cryptic colour they are not detected easily on their favourite food-plant, the *sissoo*.

Corizus rubicundus, Sign.

During February 1915 the adult bugs appeared in swarms on *Abutilon indicum* seeds at Pusa. They especially selected such pods as were half-ripe.

Serinetha augur, Fabr.

The adult bugs are sometimes mistaken for the Red Cotton Bug, *Dysdercus cingulatus*. They are at times suspected to be the carriers of *kala-azar*, though this is a mistaken notion.

LYGÆIDÆ.

Nysius inconspicuus, Dist.

This small Lygaeid has been seen clustering round the green seed-capsules of tobacco. In some years swarms of these, as well as other *Nysius* sp., may be found on the unopened flower-buds, as well as on the seed-capsules. This has also been reported from South India on gingelly (Kasargode, South Kanara).

Lygaeus militaris, Fabr.

The adults are mostly found on *Akh* (*Calotropis gigantea*) in some numbers and occasionally on cotton if the plants happen to be in the vicinity of *Akh* plants. The cultivators sometimes mistake these for the Red cotton bug, *Dysdercus cingulatus*.

Geocoris tricolor, Fabr.

Early in April 1914, whilst making a special collection of *Nephotettix*, *Deltocephalus* and *Empoasca* to make a critical study of these, my attention was drawn to an adult *Phrynomorphus* (*Athysanus*) *fusconebulosus* on long grasses at Pusa. The Lygaeid ran after the *Phrynomorphus* and thrust its rostral setae into it when it stopped at the axil of another leaf. Having done so, it remained feeding until the victim was sucked dry, when it released its hold on it and allowed it to drop dead on the leaf below. Its movements were followed for some hours, when it was again found attacking an adult *Phrynomorphus* and repeating the process as detailed above. At the time of making these observations, the adult Jassids, *Phrynomorphus*, as well as *Deltocephalus*, were fairly common on long succulent grasses at Pusa. Again, in May 1915, whilst making a grass collection, four *Phrynomorphus*, a few Pyralidae and a nymph of *Geocoris* sp., were swept out of the grasses and kept living in a pill-box. The nymphal *Geocoris* readily attacked the adult Jassids and within seven hours (9 A.M. to 4 P.M., 17th May 1915) had done to death three of them. The nymphal *Geocoris* was seen to approach its victims under confinement from the side and then thrust its rostral setae into its victims on the dorsum. The victim so attacked would be

poised high and would flap its wings until it sank with exhaustion. The nymphal *Geocoris* did not go in for any of the Pyralids in confinement.

Chauliops fallax, Scott.

The adults were received from Jeolikote (Kumaon) as destructive to beans. Mr. E. E. Green has also made the same observations, *vide Fauna of India*, Vol. II.

Jeolikote (Kumaon, U.P.)	Beans.
Ceylon	*Dolichos unguiculata.*

PYRRHOCORIDÆ.

Iphita limbata, Stäl.

At Pusa early in June 1911 numbers of adult bugs were seen to carry away ripe berries of Persian lilac to roots of *Dendrocalamus* where they had collected in numbers. The adult would roll the berry on the ground with its front legs. When disturbed, it would let go the berry, but would again return to it if undisturbed.

BERYTIDÆ.

Metacanthus pulchellus, Dall.

The adults and nymphs may be seen on Bottle-gourd creepers. The eggs are inserted into the tissues of the leaves. The nymphs as well as the adults remain feeding on the leaves especially on the lower surfase. In some years, the plants have been seen to be full of these fragile bugs in large numbers without any loss being done to the foliage. The adults may be seen *in cop.* on the plants. At times, the shoots are full of the nymphs and adults but have not been observed to wither. Young fruits as they set are affected, and exude a sticky liquid at the places the bug has fed. It has been reported from Baroda as damaging white Bottle-gourd only.

TINGIDÆ.

Abdastartus tyrianus, Dist.

The adults and nymphs have been found at Pusa on sugarcane leaves on the upper and the lower surfaces. The adults rest on the leaves at an angle and on account of their dull brown colour are not easily seen. They do not fly briskly when disturbed, but shake their bodies from side to side. The nymphs are light brown in colour and flattened in shape.

They are not found in numbers on the sugarcane leaves but in some years they are found along with male *Coniopterygidae* and *Phenice moesta.*

Galeatus (Cadmilos) retiarius, Dist.

The adults and the nymphs have been seen in some numbers on the lower surface of Bela (*Jasminum sambac*) leaves at Pusa. The eggs are inserted in the tissues of midribs of leaves and the nymphs together with their cast off moults may be seen slowly moving about the under-surface of leaves. The adults have also been reported to attack chrysanthemum leaves at Allahabad. During July-August 1914 the adults were very common on the young *Bela* (*Jasminum grandiflorum*) plants in pots kept for breeding *Dialeurodes citri* and rearing *Prospaltella* sp., parasitic on it. The leaves of infested plants turned pale yellow, especially such portions where the nymphs and adults were congregated in numbers. Such leaves ultimately withered, turned russet-brown and fell off. Affected yellowish patches on green leaves are characteristic of the presence of these bugs.

REDUVIIDÆ.

Acanthaspis ?

The nymphs are found at Pusa in the corners of houses and verandahs covered over with every kind of odd thing from small bits of wood, dust, its own cast-off skins, and other miscellaneous things which it can find handy. Whilst thus clothed, it was kept under observation as being possibly the nymph of *Triatoma rubrofasciata*. The adult, when kept in a cage and given chances to bite, refused to do so.

Pirates affinis, Serv.

The adult bug was found actively running about the verandah of a house at Pusa on the 28th May 1909. When caught by the hand it inflicted a nasty sting on the forefinger which swelled up after seven or eight minutes. Shortly after, the place stung turned deep scarlet and a great burning sensation was felt for over eight hours. The sting on the finger was plainly visible for seven or eight days after being bitten.

Ectrychotes dispar, Reuter.

On the morning of the 26th August 1911, at Pusa, an adult Reduviid was seen to pounce upon a millepede, pierce it with its rostrum and leave it dead on the ground. Three days after, two adults were kept in a cage and fed with the millepedes so common at that time of year. As soon as

the millepedes were dropped into the cage, one of the adults jumped up and settled upon the anterior part of the millepede. It grasped it tightly with its anterior and intermediate legs, then thrust its rostrum into its body when it bent over laterallly. It remained feeding thus for seven minutes when it left its victim. It then strode a little by the side of its victim and again fed on it for another three minutes. Whilst feeding, some of the adult bugs are seen to rotate round the victims with their anterior and posterior legs, the posterior legs being kept stretched wide apart.

The adult bug comes to light.

Sycanus versicolor, Dohrn.

During June 1911, clusters of eggs were found on maize leaves at Pusa. The numbers in each cluster varied from 17, 19, 23 to 29 ; a few scattered egg-clusters contained less. Each egg is 1·50 mm. long, 0·75 mm. broad, cylindrical, flattened at base, of a chocolate brown colour with the chorion finely tessellated. Each egg is provided at the free end with a whitish cup curved marginally inwards. The central area within consists of pencillar rays of solidified froth roughly dividing the area into seventeen fine divisions. The eggs touch each other at the sides, and are glued on to the foodplant with a whitish froth exuded by the female after she has laid the eggs. When the eggs are about to hatch the nymph within pushes out the cap which either drops off completely or remains attached to one side of the empty egg-shell. The amnion is then cast off and it remains attached to the mouth of the egg-shell as a crumpled pellicle of thin whitish parchment.

Nymph (First Instar)—Colour bright light orange, front of head, first, second, third and the base of the fourth antennal joints light fuscous ; eyes shiny black, rostrum reaching the anterior coxae or extending a little beyond them, a pair of thick whitish oblique setae on the vertex. Pronotum as long as the meso- and meta-nota, slightly discally raised with a central, whitish, longitudinal line on the disc. Three pairs of whitish, stout and blunt hairs on either side of the dorsomedian line. Abdomen bright red dorsally, posteriorly black. Legs black, spiny. The nymphs were fed on : *Musca* sp., Formicidæ, Nitidulidæ, *Culex* spp., young grasshoppers, and Elateridæ : of the above, they always showed a predilection for ants and Nitidulidæ.

Endochus sp. (near *cingalensis.*)

Clusters of eggs were found at Pusa on *Tur* (*Cajanus indicus*) leaves, the numbers in various clusters varying from twelve to thirty-five. Eggs

laid on the 27th November 1912 hatched on the 16th December 1912. The newly-hatched nymph looks superficially much like an ant.

The Nymph (*thirty hours after hatching*). Colour pale fuscous, eyes deep sanguineous with prominent facets ; vertex, rostrum, femora, tibiæ and abdomen, antennal fourth to fifth joints, light, pale brown ; front of head, the notum trans-dorsally, first and second antennal joints, femora and tibiæ apically, tarsal joints, spiracular openings, and three small ovoid spots on the abdomen dark fuscous ; rostrum pale yellow, sharply bent, reaching the middle of prosternum apically, suffused with pale brown ; apex of first and base of second rostral joints light fuscous ; first antennal joint longer than the second and third joints together, third dark fuscous with stout hairs on it, fourth and fifth joints thin and wiry with the apex of fifth joint slightly swollen. Femora and tibiæ sparsely spiny, with the apex of tibiæ slightly swollen.

On hatching, the nymphs remain congregated and as such look like a cluster of black ants. They fed on Cotton Aphis and grew to moult to attain the third instar when they became very active and died in numbers.

Triatoma (*Conorhinus*) *rubrofasciata*, De Geer.

The Reduviid is believed by some to be the carrier of Leishman Donovan bodies which cause *kala-azar*, which fell disease has become very prevalent in Pusa and its vicinity. On the Pusa Estate there have been eleven cases of late, and a visit to the Pusa hospital would convince one that the disease has got a stronghold at least in the districts of Darbhanga, Muzaffarpur and Saran (Chapra) in North Bihar and could be traced to the exodus of coolies who yearly migrate to Assam during summer and winter months and return home during the Rains. In view of the facts I have been keeping an eye on these bugs during the past twelve years, the first specimen being caught by me at light on the 25th March 1912. The second was caught during September 1914. I am led to conclude that the bug enters houses in the early morning hours between 1 to 4 A.M. It comes to light, especially if a lamp is kept lit during the early morning hours. In the Pusa collection the specimens are from :—

14th August 1904	Surat.
19th April 1904	Surat, at light.
25th March 1912	Pusa, at light.
27th June 1922	Pusa.
10th September 1913	Beeravalli (Bellary district.
September 1914	Pusa, at light.
1st November 1915	Bankura (Bengal). At light
...	Madras.

CAPSIDÆ.

Gallobelicus crassicornis, Dist.

These fragile but active light-green insects are found in all stages of development on tobacco seedlings, especially the top-shoots. The adults as well as the nymphs become torpid with cold ; they are most active during the hottest part of the day. They fly actively and the least disturbance sends them flying about. The male is smaller than the female and numbers of them may be seen *in cop.* on the tender tobacco plants as well as on the gourds. The eggs are laid singly in the tissues of the midribs of leaves and are somewhat curved in the middle and rounded posteriorly. Each egg has a pair of fine threads attached to it at its free ends. These hairs, owing to the gibbose nature of the cucurbit leaves, are not easily seen with naked eyes. When the nymph is to come out, a slit opens in the free end and the nymph comes out. It then lies motionless for some time near the egg-shell. From occasional collections it has been found that the females outnumber the males. The adults are found on gourds along with the Berytid. *Metacanthus pulchellus*. The adults have also been found on a Composite weed growing profusely on field embankments at Pusa.

ANTHOCORIDÆ.

Septicius clarus, Dist.

A few adults were attracted to meat kept for the purpose of breeding Sarcophagids at Pusa. The adults would settle on bits of flesh exposed in breeding dishes, thrust out their rostrum and suck the juice, their abdomen becoming red and distended with it. A few adults were treated with xylol × phenol to make permanent balsam mounts when it was observed that, when the body juice came in contact with the clearing medium, it turned pale brown.

Triphleps tantilus, Motsch.

Whilst searching for the adults and nymphs of an Aleyrodid on *Euphorbia pilulifera*, I was bitten severely by an adult. When about ho suck, the adult raises its body on its hind legs and thrusts in its rostrum. Tee bite is sharp and is felt instantaneously and the bug settles down on the exposed part to feed.

HENICOCEPHALIDÆ.

Henicocephalus basalis, Westw.

During February (6th-14th) 1910, numbers of adults were seen at Pusa in the verandahs of houses, roads, grassy lands. Only the adults were thus seen, but not the nymphs.

On the 7th June 1911, on a very warm afternoon, a swarm of adults, thirty to forty in number, was seen flying six to seven feet above the ground. They appeared in the North-East, arising over the bank of the river Gandak and flying South-West in the direction of the wind. Whilst on the wing they appeared like a swarm of Scolytid beetles, moving rapidly with the wind. During the latter part of the month, adults were found at Pusa on shrubs, verandahs of houses and bamboo railings around experimental plots.

On the 23rd June 1911 another swarm was seen to fly over grassed land near the Phipps' Laboratory at Pusa. On the 26th June a few more were found resting on a piece of white cloth stretched on two bamboo poles and on the following day a few settled on my white shirt, crept within and bit me. The bite was very irritating and like that of *Triphleps*.

PELOGONIDÆ.

Pelogonus marginatus, Latr.

The adults are common at Pusa from January to the beginning of March. They feed on an aquatic weed and are very agile. They skip about from plant to plant, and when disturbed readily take to wing When they are feeding, their antennæ are kept in constant motion. The adults are conspicuous on account of their colour and large reddish-globose eyes.

NOTONECTIDÆ.

Anisops sardea.

On the 17th April 1911 ten nymphs and one adult were put in an aquarium with 27 small mosquito larvæ and 7 small mosquito pupæ; on the following day, 8 nymphs (mosquito), 2 adult mosquitos, 1 dead mosquito, were found in the aquarium. The same day at 8 A.M. a number of mosquito larvæ (the exact number was not counted) were put in the aquarium. By 10·50 A.M. the same day, ninety-three carcasses of larvæ

were found floating on the surface of the water. The adults jump out of the cage if it is left uncovered. Though the nymphs and adults remain together, the latter do not attack the former. On the 5th May 1911, an imago was kept without food for two days when it was transferred to a dish containing Chironomid larvæ. The adult bug attacked and sucked a larva as it wriggled up the surface of water. It was not observed to attack such larvæ as remained at the bottom of the dish either free or encased in mud cells. It was also observed to attack Ephemerid larvæ which were introduced later on into the dish. The adults do considerable execution among mosquito larvæ, swimming up to them from below and sucking them dry by means of the strong, bent proboscis.

Enitheres indica, Fabr.

On the 19th July 1911 an adult was caught in one of the jute-retting vats at Pusa and put in a glass tube, when thirty eggs were laid loosely on the sides of the tube. The egg is pale yellow in colour, pointed at one end, centrally flattened and the chorion is beautifully sculptured with hexagonal designs. There is a small transparent cap over the micropyle. Twenty-four hours after deposition, the egg turns pale yellow with two light orange spots below the micropyle. When examined under the microscope, the chorion being thin and transparent, the motions of the developing nymph within could be seen distinctly. The nymph has bright pink eyes with the rostrum and the legs adpressed closely to the sternum, and the thorax and abdomen pale yellow. The legs extend beyond the abdomen. A nymph was noticed to make a complete revolution in two minutes and fifty-two seconds. The eggs, when dropped into the water, sink immediately.

On the 9th April 1911 an adult *Enitheres* was observed to suck an adult *Anisops sardea*. They have also been observed to attack and suck mosquito larvæ.

Plea sp.

On 18th April 1911, the nymphs, as well as the imagines of this insect, were noted to prey upon mosquitos, but they are not so voracious as the nymphs of either *Enitheres indica* or *Anisops sardea*. As the mosquito larvæ are very active the nymphs of *Plea* sp. are not able to catch them easily. As soon as the nymph approaches a larva the latter wriggles away and thus easily eludes its enemy. The nymph then pursues another (in the aquarium) and tries to reach its victim from the side. If it is able to catch its victim it is joined by another and in an aquarium it is not an unusual sight to see two nymphs feeding together upon the same.

larva and swimming with it firmly transfixed to their rostra on the surface of the water. The nymphs of *Plea* sp. have been observed during the early part of May to prey upon *Ephemerid* larvæ so common in the river Gandak close to Pusa. They were then observed to prey more upon Ephemerid nymphs than on mosquito larvæ. The adult *Plea* sp. attacks only small mosquito larvæ. The older larvæ, which are more active, wriggle away and thus escape their enemies. A few pupae were also (5 V 1911) attacked by the imagines, but this was rather rare.

HYDROMETRIDÆ.

Microvelia singalensis, Kirk.

On the 12th April 1911, four imagines were put in a glass dish containing mosquito larvæ but they did not touch them. Three days later an eggmass of a mosquito was introduced into the dish when all four attacked it immediately from three sides. At times, one of the imagines was seen to mount the eggmass and to feed on the eggs from above. The number of eggs in the mass was sixty, and out of these only a few hatched out.

Gerris nitida, Mayr.

On the 31st March 1910, at Pusa I saw an adult feeding upon a *Tridactylus* sp. which was blown into the water. The adult bug was swimming slowly near the water's edge, when its prey fell into the river. It jumped upon it immediately, caught hold of it with its legs and sucked it dry.

NEPIDÆ.

Ranatra elongata, Fabr.

Two species, *Ranatra filiformis* and *R. elongata*, are fairly common at Pusa. Their eggs are mostly found during March and are laid on aquatic weeds. The nymphs have been fed on mosquito larvæ. As soon as a mosquito larva was dropped into the aquarium the adult bug would shoot out its legs, seize it and transfix it on its proboscis. If, however, the larva wriggled much, the other leg was promptly brought over to keep it steady. A suck for a few seconds would render the larva flabby and cause its ultimate death. Sometimes a *Ranatra* was seen to have a mosquito larva in its front legs with the rostrum thrust into the body of its victim. Eggs and nymphs are found in numbers during March and April.

FULGORIDÆ.

Dictyophara nigrimacula, Walk.

The imagines feed on grasses, bamboo leaves, guinea-grass and sugar-cane leaves, though not in large numbers. Early in 1916 they were to be found along with *Pyrilla pusana* on guinea-grass at Pusa in fairly large numbers.

Dictyophara sauropsis, Walk.

The adults are found in numbers on *Tamarix gallica* leaves and stems at Pusa. They are cryptic in colour and as such are hardly seen against the greenish background of stems, but their presence is betrayed by the presence of ants which attend them for the sake of the honey-dew. The adults are attracted to light and are common in houses, especially in the beginning of the Rains.

Phromnia marginella, Oliv.

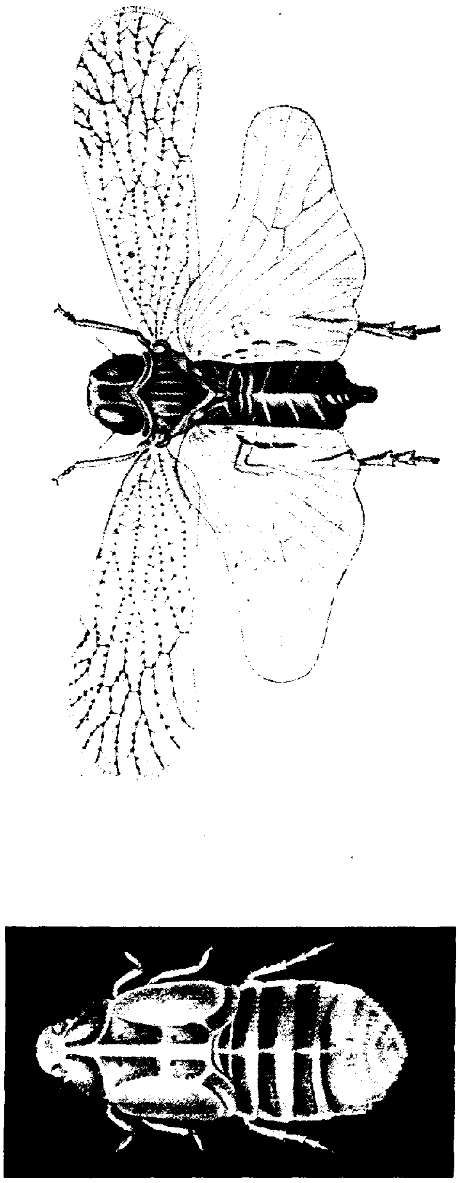
Nymphs and adults were observed by me at Jeolikote (Kumaon, U.P.) in fruit gardens. The nymphs were present in such large numbers on plums and nectarines that the infested trees looked white from a distance. The nymphs, as well as the adults, exude honey-dew so copiously that it consolidates and appears in the form of big oval drops. The adults have also been seen in much the same way as above at Dharmsala, Kangra and Nainital. The nymphs are parasitized heavily by a Hymenopterous parasite.

Melicharia lutescens, Walk.

The adults and nymphs are found in numbers at Pusa on *Zizyphus jujuba* trees. The nymphs are thickly covered over with cretaceous bloom, as well as threads at their anal ends. It is on account of the frequent rupture of cretaceous threads that the lower surface of leaves becomes coated thickly with whitish bloom. Attempts were made last year to rear these in captivity and to see if these contain Epipyropid larvæ in their pygidial cretaceous threads, but no larvæ were found. On the 27th July 1907, an adult, as it rested on a jute plant, was pounced upon by an Asilid fly and taken away.

Purohita cervina, Dist.

The adults are found at Pusa from the beginning of November to the end of January on bamboo stems. Their presence is known by a



***Oliarus walkeri*, Stal, on roots of grass ; nymph and adult ; both magnified 12 diameters.**

thick deposit of cretaceous white threads on the stems. The nymphs are gregarious in habit and may be seen feeding in clusters on the tender shoots. So copious is the exudation of honey-dew that it falls heavily on the leaves and gives rise to the growth of *Capnodium* sp. The female makes a longitudinal slit in the stem and lays the eggs in it. Their number in a cluster varies from seventeen to twenty-two. When the female has laid all the eggs, she covers them up with white cretaceous threads removed from her pygidial end.

Oliarus walkeri, Stål. (Plate 29).

The nymphs have been found on the roots of Dhub grass (*Cynodon dactylon*) a few millimetres underground, whilst the adults have been seen feeding on the leaves. The nymphs are very sluggish and, even when disturbed, do not fly much. On the contrary, the adults are very active and prefer to remain on the lower surface of leaves. The nymphs of the early instars are covered over with a thin whitish bloom. They have a thick waxy tuft of hairs at the anal end. This, if accidentally broken off, reappears within seventeen hours and asssumes its normal shape within forty-eight hours. In one case the nymphs together with their adults were found close to a subterranean nest of ants and in several cases when infested *Dhub* grass-roots were opened for examination, they were found covered with a white bloom. The nymphs as well as a few adults were found at Pusa in the middle of winter (1910).

Nisia spp.

During September 1910, these tiny Fulgorids were found in numbers on *Tamarix gallica* stems and leaves at Pusa, and during the same month the manager of a local Indigo Factory reported that Leaf-hoppers were damaging his ratoon crop of indigo. An examination of the crop showed that, along with the Indigo Psylla (*Arytaina isitis*), numbers of these tiny whitish bugs were also present on the leaves. The drought then prevailing seems to have favoured their development and adults were then to be seen on castor, sugarcane, cotton, juar (*Andropogon sorghum*), *Eleusine coracana* and *Phaseolus radiatus* at Pusa.

Hilda bengalensis, Dist.

The nymphs and adults are present in numbers on *Ficus religiosa* trees at Pusa. The eggs are laid in clusters on the leaf-stalk, the edges of a leaf and the lower surface of leaves. The number of eggs laid by a female has been found to vary from 76, 82 to 93. Each egg is from

0·66 mm. to 0·75 mm. long and 0·38 to 0·30 mm. broad; cylindrical, pale yellow with a slight suffusion towards the end bearing a cupshaped process on a short peduncle. The circumference of the cup is 0·06 mm. The chorion is sculptured beautifully with fine hexagonal patterns. The eggs are laid flat on the surface of leaf-stalks, and touch each other at the sides. The peduncles with cups on them do not always point in one direction only. Prior to hatching, the eggs turn pale brown with two bright spots at one end near the base of the peduncle. These represent the compound eyes of the nymph within the egg-shell. When the nymph is about to emerge, the portion below the peduncular process bursts open and the head is thrown out. Shortly after, the legs come out and the nymph rests for some time in this position. The presence of the short stout hairs on the vertex and the dorsum of the emerging nymphs seems to widen the opening and to facilitate their emergence. The nymphs after emergence wander about and congregate to feed together. They are then attended by ants (*Œcophylla smaragdina*), which seem to guard them and resent external interference. In one case two adult bugs were disturbed purposely and these ran down the stem on which they were present, but before they could reach the base of the stem, an *O. smaragdina* had shot forth ahead and prevented them from descending to the ground. The ants attend upon the nymphs as well as the adults for the sake of the honey-dew. The empty egg-shells remain attached to the leaf-stalk, thin edges of leaves and in places where they were deposited. The eggs are parasitized by a Chalcidid which may be seen resting on the eggs and ovipositing in them. The parasitized eggs turn dark-grey and as such become distinct. The eggs from which the parasites have emerged have a circular hole in them. It is on account of the parasites that the number of bugs is considerably kept down. The nymph (two hours after emergence) is pale white, translucent, with a large number of stout hairs on it; eyes deep red; vertex broad with a double row of short thick hairs on it; legs thick, whitish, spiny; thorax distinctly transversely carinated; pro- and meso-nota nearly sub-equal, metanotum nearly half as broad as either pro- or meso-notum, rostrum pale white, projecting beyond the body, clavate at apex; abdomen light pale-yellow, distinctly transversely carinated; segments nine, distinct. The adult bugs have been seen on *Cassia fistula* and *Loranthus* sp.

Lawana conspersa, Walk.

Nymphs are found occasionally at Pusa swarming in numbers on the stems of *Citrus* spp. They are covered thickly with a cretaceous white flocculent material, and when they move about on the branches, these

become coated with the remnants of cretaceous threads from the anal ends of the nymphs, so that the infested plants look white from a distance. Along with the nymphs, adults are also present on the infested plants. A large number of nymphs were examined for the presence of Epipyropid caterpillars, but none were found.

MEMBRACIDÆ.

Leptocentrus taurus, Fabr.

A large number of adults were found in the middle of June 1911 on *Tamarix gallica* at Pusa and these were then attended by the red ant, *Œcophylla smaragdina*. If the adults were disturbed, the ants would resent interference.

Gargara mixta, Buckt.

Eggs, nymphs and adults were found in large numbers on *Sesbania aegyptiaca*. So heavy was the infestation during April 1915, that within a distance of 40 millimetres there were fifty-nine egg-masses, the number of eggs in each mass varying from five to eighteen. The female, when about to deposit eggs, lacerates the tissues with her strong ovipositor and thrusts in the eggs at an angle to the surface of the stem. The nymphs in the early instars are light green, in keeping with the colour of the stems on which they remain feeding. In some cases the eggs are aid in tiers, one above the other. The eggs were found to be heavily parasitized; the parasitized eggs turn black, and as such are detected easily. On the 22nd March 1911, whilst making observations on the habtits of the nymphs and the adults, I saw an adult *Coccinella septempunctata* devouring a nymph of this Membracid.

Oxyrhachis tarandus, Fabr.

The adults and nymphs have been reported doing damage to *Acacia richii* in the Municipal Gardens, Bombay. At Pusa the eggs, nymphs and adults are found in numbers on *Acacia arabica*, *Cassia fistula* and *Albizzia lebbek*. The presence of the nymphs and adults is easily known by the presence of *Camponotus compressus* which attend on these in numbers for the sake of the honey-dew. The ants, at times, are so persistent in their demands for honey-dew, that the egg-laying females have been observed to postpone egg-laying to attend to their demand for the supply of the viscid liquid. The eggs are laid in large numbers in the tender shoots of trees, and in the bark of old trees.

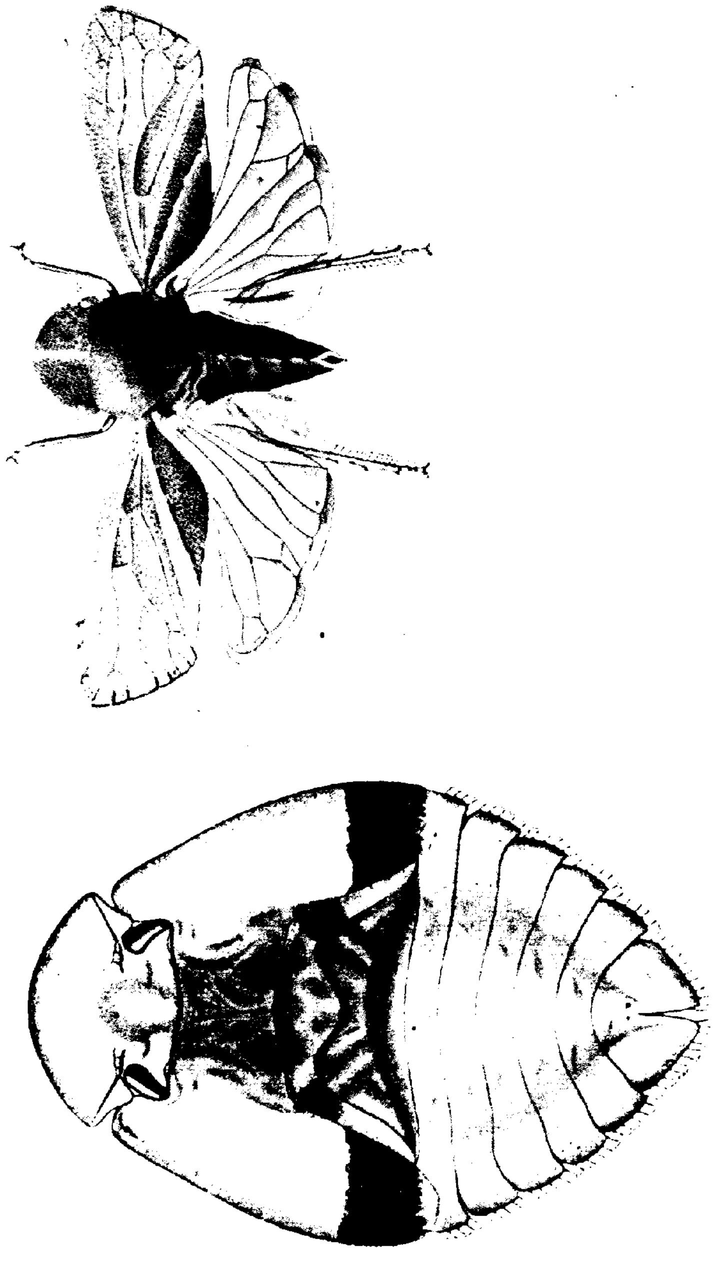
The eggs are laid in clusters in lines which converge acutely at one end. At times the eggs are laid so profusely that the bark swells and forms nodular outgrowths. The eggs are heavily parasitized by a small, black Chalcidid and then turn black. Such eggs may be readily distinguished from healthy ones by the presence of circular holes in them. An egg is 1·25 mm. long, pale yellow, pointed at the free end, broad and flattened towards the end which remains embedded in the tissues of the foodplant. At this end there is a sharp bent spine which also remains embedded in the tissues of the plant. When the nymph is to come out a slit opens on the free end and a dusky yellow insect with a pair of reddish eyes comes out. Five hours after emergence, the colour deepens into pale fuscous with deep pink eyes. The nymph is then a millimetre long with a few short, porrect hairs on the vertex, the prothorax broader than the meso- and meta-thoraces, eyes deep maroon, femora thickened with posterior tibiæ incurved exteriorly, tarsi three-jointed with the first joint longest. The nymphs do not fly or move about fast. They are gregarious in habit and are attended by ants.

CERCOPIDÆ.

Ptyelus affinis, Dist.

During the middle of September 1916, a large number of "Cuckoo-spits" were found on *Abutilon indicum* at Pusa. The adults were found on the leaves in fairly large numbers. The eggs are laid in slits made in the leaf-stalks, and the empty egg-shells remain embedded in the tissues, after the nymphs have swarmed out. On a plant there were from six to eleven "spits," each containing a nymph. When a large quantity of froth accumulates it falls down in clear drops on the leaves below. An observation of the nymphs within the "cuckoo-spits" showed that none were parasitized. If a nymph is taken out of the froth and put on a succulent part of the stem, it soon begins to feed and to exude a clear liquid which it beats up with its anal end into a frothy mass.

On the 13th September 1919, the Veterinary Assistant, Bardoli, Bombay Presidency, sent a number of nymphs within frothy-coverings and remarked that the cultivators in the locality thought these insects to produce a kind of contagious cattle disease, a kind of Dengue fever or Ephemeral fever or three days fever known in Gujrati as *Tontieu*, especially when cattle took these into their system along with *Mung* (*Phaseolus mungo*), *Moth* (*Phaseolus aconitifolius*) and *Juar* (*Andropogon Sorghum*), on which they were found. As the nymphs died in transit, the adults could not be reared from them.



Petalocephala granulosa, Distant.
Nymph, dorsal view, from mounted specimen, ×16 ; adult, ×8.

Petalocephala granulosa, Dist. (Plate 30).

The nymphs and the adults have been seen at Pusa on mango leaves. They are coloured cryptically and as such are not seen readily. A number of nymphs may be present on the infested leaf, but their presence is not known on account of their flat bodies, resting mostly on the midribs of leaves. When disturbed, the nymphs move about slowly along the midrib, and if violently shaken they fall down on the leaves below. They have been seen invariably feeding on fairly tough green leaves and mostly on the upper surface. No nymphs have hitherto been seen by me on the apical cauline leaves. The parasitized nymphs turn dark grey and show a circular hole of exit of the parasite.

Kala Azar infection experiments with *Triatoma* (*Conorhinus*) are **Mr. Iyengar.**
being conducted in the School of Tropical Medicine, Calcutta. It is unsafe to generalize about the connection between Kala Azar and the bug until some definite results have been obtained. *Conorhinus* has been found on the bed of a Kala Azar patient. On the other hand at Sibpur, near Calcutta, *Conorhinus* is plentiful but there is no Kala Azar.

Nothing is known about its normal habitat; it is supposed to live **Mr. Fletcher.**
in squirrel's nests.

I have found them living in godowns in Calcutta in which rats were **Mr. Iyengar.**
abundant.

46.—THE COLLECTION AND STUDY OF INDIAN ORTHOPTERA.

By B. P. UVAROV, F.E.S., *Assistant Entomologist, Imperial Bureau of Entomology.*

The Orthoptera form, undoubtedly, one of the little collected and less well-known groups of Indian insects, notwithstanding the fact that many members of this order are serious pests of various crops. The most important family of Orthoptera, from an economic view point, are the Acrididæ*, or short-horned grasshoppers, to which belong the swarming locusts, rice grasshoppers (*Hieroglyphus*) and a good many other minor pests of Indian agriculture; the present paper deals with this Family in the first place, though most of what I am going to say may be equally well applied to other families of Orthoptera.

Apart from descriptions of some odd species of grasshoppers from India, scattered in the general systematic literature, there are but very few publications dealing especially with the Indian *Acrididæ*. Brunner von Wattenwyl (see bibliography at the end of the paper) published in 1893 a list of Orthoptera collected by Leonardo Fea in Burma, including about fifty species of Acrididæ, a little less than one half of them described for the first time; the paper is, of course, very important for the study of the Indian fauna, although it deals with but a small and, faunistically a highly peculiar, corner of India and with a very limited number of species; some of Brunner's identifications of previously known species are evidently incorrect, while his descriptions of the new species are often insufficient for their recognition without a study of the types.

A very important and valuable contribution to the knowledge of the Indian fauna has been made by I. Bolivar (1901) who published an extensive list of Orthoptera of South India, based on the collection of the Trichinopoly College. This paper, containing numerous descriptions of new genera and species, is very valuable for a student of Indian Orthoptera, although again it deals with the fauna of but one small part of India. Bolivar's descriptions are, on the whole, satisfactory,

* Some authors follow Kirby in calling this Family Locustidæ which is both incorrect and misleading, since the latter name has been for many years incorrectly used for the long-horned grasshoppers (*Tettigoniidæ*); the name Acrididæ is derived from *Acrida*, the oldest genus of the family, and must not be confused with *Acrydiidæ* (= *Tetrigidæ*) based on *Acrydium* (= *Tetrix*).

but in many cases they are somewhat superficial and do not answer the purposes of modern systematics, so that a study of his types also is quite necessary; unfortunately, Bolivar has kept in his collection only duplicates (paratypes) when available, while all single types have been returned to Trichinopoly and are, I am afraid, lost or destroyed.*

The first and only revision of the whole of the Indian fauna of *Acrididæ* has been given by Kirby in the "Fauna of British India" series in 1914. As this book is supposed to represent a standard work on the subject, it may be useful to discuss its merits and faults. Kirby was in an unique position with regard to the numerous (about fifty) species described from various parts of India by Walker, as he could examine their types, without which examination it is impossible to recognize Walkerian species; this important part of the revision has been done by Kirby in a most unsatisfactory way, since very many of Walker's species have been referred by him to wrong genera, while others have been obviously incorrectly identified with species described by other authors. Thus one confusion in the synonymy, which had been bad enough before Kirby's book, became a great deal worse after its publication. Apart from the numerous mistakes in synonymy, the book abounds in proofs that the author knew very little about his subject, since the descriptions of the genera and species (as far as they are original) provide ample evidence of Kirby's lack of knowledge of the morphology of the insects studied. The matter has been still more aggravated by the fact that Kirby died without having completed his manuscript, and the difficult task of preparing the book for publication was undertaken by Waterhouse who knew nothing about the group and could not help making some most unfortunate mistakes. As for the original material included by Kirby in his book, this originated, it seems, from two principal sources—the Pusa Institute, and Mr. E. E. Green's collection from Ceylon—but they have not been worked out completely and what I have seen of the named specimens compels me to discredit the majority of Kirby's records on the distribution of species.

Additions and some corrections to Kirby's book have been published recently by I. Bolivar whose work (1918) has been based on materials from the Coimbatore Agricultural College and includes some new genera and species, and by myself when I worked out the portion of the Pusa collection sent to Kirby but unnamed (or misnamed) by him. Both these papers are, however, quite occasional and do not aim at correcting Kirby's book as a whole, which would be hardly possible and at any rate decidedly less useful for Indian entomologists than a completely new

* I understand that this collection perished many years ago.

T. B. F.

revision of the whole fauna, with new keys and re-descriptions of species, which would make identification of specimens both easy and (what is more important) quite reliable.

A revision of this kind is being contemplated by myself and will be based on the collections of the British Museum containing all the types of species described by Walker and Kirby, while there is also every prospect of an examination of types of Bolivar's, Brunner's and Stal's species. A large amount of unnamed material is being sent from Pusa and Coimbatore and a superficial examination of it shows that it contains many undescribed species and genera, but in order to make the intended revision as complete as possible, much more collecting should be done and the purpose of the present paper is to draw the attention of Indian entomologists to the necessity of collecting Acrididæ and to give them a few hints as to where and how to collect.

As regards localities the fauna of which requires a thorough investigation there is little to be said, since practically the whole of India remains unexplored. Some parts of it are, however, of particular entomo-geographical interest and at the same time their fauna is almost unknown. Thus, the deserts of Sind and the Punjab must harbour a very rich and highly specialized fauna, but only a few species are known from these areas and these species are all very peculiar. To what an extent the desert fauna of Western India and the adjoining areas is unexplored, may be judged from the fact that not a single specimen of Orthoptera from the Indian desert has ever reached the hands of a specialist, whilst the experience of collectors in Persia, Turkestan, Mesopotamia and other desert countries shows that the Orthoptera always play a very prominent part in their insect fauna. Sandhills, stony ridges and hills, clay or salt plains and other typical desert formations, possess each a peculiar fauna of Orthoptera consisting of species adapted to particular conditions.*

Another *terra incognita* is comprised in the alpine regions of the Himalaya, while odd specimens of Orthoptera coming from there give ample evidence as to the extreme peculiarity of their fauna, consisting largely of small species with abortive organs of flight, which makes them very much like larvæ and undoubtedly prevents some collectors from taking them. Such larva-like forms are very common also in the higher regions of the Nilgiris and other hills, which fact must not be forgotten by collectors there; in case of any doubt as to whether the particular insect is mature or not, it is advisable always to keep the specimens

* Apart from my revisional work on the *Acrididæ* of the whole India, I am quite prepared to undertake the identification of any Orthoptera from the desert and alpine localities.

and be on the safe side than to throw away a possible novelty of high zoö-geographical value, as most of these flightless grasshoppers are.

The lower regions of the Himalaya are also very badly known as regards their fauna of *Acrididæ* which seems to be very rich in the smaller species of the genera *Aulacobothrus*, *Leva*, *Stauroderus*, etc., abounding on grassy slopes and in other open spaces. Here, by the way, the contact of the Palæarctic fauna with the Oriental one must be looked for and all records of occurrence of even the most common and well-known species on the Southern Himalaya are very valuable from that point of view, quite apart from the fact that the majority of smaller species are undoubtedly undescribed.

It may seem odd, but it is nevertheless a fact, that the grasshopper fauna of the plains of Central India is also very inadequately known—at any rate, less so than that of Southern India, for instance. Of course, there is a large amount of unnamed material from the Plains in the Pusa collection, but still more extensive collecting is necessary in order to obtain a list of species as complete as possible.

In collecting *Acrididæ* for the purpose of a revisional work it must never be forgotten that long series of specimens of each species are the only means to establish the extent of variability (individual, geographical, etc.) of characters and thus enable the student to appreciate their taxonomic value. In fact, I shall hardly make a mistake in saying that not less than one-half of all the species hitherto known have been described from single, or very few, specimens, which makes it very difficult to decide what characters, supposed to be specific, are actually so. The necessity of studying long series applies even to the most common and numerous species including those of economic importance. Thus, my revision of the rice grasshoppers (*Hieroglyphus*) has given some indications that the most widely known species, *H. banian*, F., may occur in two forms, well characterized morphologically, but connected by intermediate ones ; it seems that one of these forms (var. *elongata*, Uv.) appears in years of the mass development of the species and corresponds to the "swarming phase" discovered by me in practically all migratory locusts. Even if it is not so, there is no doubt that *H. banian* is subject to variations according to years, and it is only by collecting and studying a mass of material obtained from the same locality during several years running, and from different localities in the same year, that the true character, meaning and, probably, causes of the variations may be found out, which may be of great practical value.

As regards methods of collecting *Acrididæ*, there is hardly anything particular to be said. A stout net, made of some strong fabric, and used for sweeping is the only apparatus required, but it must be noted that

some species, especially those living in bunch-grasses in deserts and plains often avoid being " swept " by falling down at the slightest disturbance *and hiding between the stems near the ground, where they may be de*tected by a careful search.

Killing of grasshoppers is best done in a cyanide bottle which should be large enough and with a good supply of blotting paper ; the specimens should not be kept in the bottle too long, or else they may change their colour.

The preservation of specimens of Orthoptera seems to the majority of collectors a very difficult task, since the comparatively large size and very fat and juicy bodies of these insects are the causes of the specimens decaying rapidly if not properly handled ; these qualities make the whole group anything but favoured by collectors. The means to prevent the decay of specimens are, however, quite simple. In fact, when dealing with specimens of small and medium size, all that is necessary is to take out of them the superfluous moisture. In order to do it, the abdomen (but not the breast) must be cut open, by means of a pair of fine, sharp-pointed scissors, along the thin membrane between the tergites and the sternites, on one side only ; particular care should be taken not to cut the last two segments, as they supply very important taxonomic characters. Then a piece of blotting-paper, folded several times, must be inserted into the opening and left there for five to ten minutes ; the blotting-paper must be changed two or three times, until there is no more moisture to extract. The opening then should be closed by means of a forceps and the insect is ready. Some of the largest specimens require a little more work, since it is necessary to remove all of their insides (intestines, crop, ovaries, etc.)— which is easily done through the same opening ; the inside of the abdomen must then be dried by blotting-paper and stuffed with cotton-wool. In dry weather, there is practically no necessity for stuffing even large specimens, provided they are dried as indicated above.

The equally good methods may be recommended for the temporary preservation and transportation of collected specimens. The first one is to wrap the specimens singly in a porous, but not soft paper, or still better, to place them in cylindrical tubes made of paper, with the diameter corresponding roughly to the thickness of the specimens. Such tubes may be kept in a well ventilated wooden box (not in a tin), and for transportation must be packed rather tightly to avoid shaking.

Another method of preserving specimens is between layers of cotton-wool, which must be cut in layers, about one centimeter thick, and of a size exactly corresponding to the wooden box intended for the specimens ; the box must be filled tightly with the layers, every one of which must

be separated from the next one by a sheet of thin writing-paper of the same size as the layers are. First, all the layers but the bottom one are taken out of the box and the specimens (with the moisture extracted, or stuffed, but quite fresh and flexible) are placed on the remaining bottom layer, fairly close to each other and in more or less regular rows; each specimen is better laid on its side, with the antennæ and legs close to the body. When the first layer is filled, it must be covered by a sheet of paper on which all particulars relating to the specimens should be written; then the next layer of cotton-wool is put on the top of the first one, and so on. When all the specimens collected on a certain day are disposed of in that manner, the remaining empty layers of cotton-wool must also be put in the box in order to press the insects in the cotton-wool and thus prevent their shaking during transportation. The captures of the next day are placed in the box in the same way, always on the lowest still unoccupied layer. This method is largely used for temporary preservation of all insects by Russian entomologists, and I have always applied it for transportation of Orthoptera, with the very best results. One thing, however, must be mentioned, namely, that when damping the specimens thus preserved before their pinning, they must not be taken from the cotton-wool one by one, but the whole layers with the insects on them must be placed in the damping tin.

No special instructions are wanted for pinning grasshoppers and as for their setting, the best way is to set out only one pair of the organs of flight (usually, the right one) and leave the other as it is. The importance of careful and detailed labelling of the specimens is already perfectly well-known to Indian entomologists, if I may judge by the collections studied, and I need not dwell on that point.

Some more important works on Indian Acrididæ.

1893. *Brunner de Wattenwyl.* Revision du systeme des Orthopteres et description des especes rapportees par M. Leonardo Fea de Birmanie. Ann. Mus. Civico di Storia Naturali di Genova, ser. 2, vol. XIII (XXXIII); pp. 102-164, pl. V.

1902. *Bolivar, I.* Les Orthopteres de St. Joseph's College, a Trichinopoly (Sud. de l'Inde). 3e partie. Ann. Soc. Ent. France, LXX, pp. 580-634, pl. 9.

1914. *Kirby, W. F.* The Fauna of British India. Orthoptera. (*Acrididæ*). 276 pp., 140 figs.

1918. *Bolivar, Ignacio.* Contribucion al conocimento de la fauna India Orthoptera (*Locustidæ* vel *Acrididæ*). Revista Real Acad. Cien, Exact., Fisic. y Natur. de Madrid, XVI, pp. 278-412.

1921. *Uvarov, B. P.* Records and descriptions of Indian Acrididæ. Ann. Mag. Nat. Hist., Ser. 9, vol. VII, pp. 480-509.

1922. *Uvarov, B. P.* Rice grasshoppers of the genus *Hieroglyphus* and their nearest allies. Bull. Entom. Res., XIII, pp. 225-241, 3 figs.

Mr. Fletcher, in commenting on this paper, emphasized the need for extensive collections of Orthoptera of India and especially grasshoppers and their submission to Pusa, this being one way in which the Provincial Entomologists could assist. We were prone to assume that well-known insects were not worth collecting; as is pointed out in the paper, this is very far from being the case.

47.—RECENT PROGRESS IN OUR KNOWLEDGE OF INDIAN DIPTERA.

By R. SENIOR WHITE, F.E.S.

Since the last Meeting the following notes show that quite a considerable amount of accessions to our knowledge of the Indian dipterous fauna have been made.

The most spectacular discovery has been that of Edwards[1], who has erected a new family *Deuterophlebiidæ* for a most remarkable insect from Kashmir, probably the most aberrant dipteron yet known to science (excluding the forms retrograded by parasitism), which is so unlike anything hitherto known in the Order that it was a matter of considerable difficulty to decide whether it was a dipteron at all, its general appearance being Neuropteroid.

The largest and most valuable accessions have occurred, as might be expected, in *Culicidæ*. Edwards[2], in an epoch making paper, has condensed the results of many years study into a form whereby, for the first time, it is possible to determine the genus and species of a Culicine mosquito without reference to half a hundred scattered papers only accessible to the specialist. None the less, the results of his work can only be described as iconoclastic. Although it is several years now since Brunetti sounded the tocsin of revolt against the multiplication of genera in this family on behalf of India, the holocaust of the present paper leaves even the dipterist dismayed ! It is only just over a year since the Writer, in consultation with Mr. Carter, then freshly out from Home and *au courant* with the latest thought on this matter, compiled what he considered a list of valid genera in the family as represented in the East, and now even such well-known concepts as *Stegomyia*, *Ochlerotatus* and *Toxorhynchites* are gone ! Practically, we are back as regards genera to where we were when mosquitos were only studied as one family of Diptera in the days before Ross' discovery. The genera erected by dipterists have been found sufficient, with comparatively few additions, to contain all the hosts of new species discovered by the Culicidologists. Limbo has received the concepts of the Theobaldian School.

In regard to mosquito surveys, of which there cannot be too many having regard to the necessity for obtaining data concerning the water preferences of the various species, notes on surveys in Calcutta and a typical sub-montane Ceylon rubber estate have been published by

Iyengar [3] and the Writer,[4] whilst a recent paper by Hill [5] on Queensland species and their habits is worthy of study by Indian workers, as about half the species there mentioned are found in our Region.

None the less, bionomically, the outstanding results have been obtained in Malaya, where Hacker[6] has developed the idea of 'Association Units' in the search for the larval water preferences of Anophelines, by means of which he has been able to group, with a considerable degree of mathematical accuracy, the genus into 'large' and 'small pool-breeders,' 'stream breeders,' 'jungle' and 'open country' species, etc., whilst the problem has been carried further by Lamborn[7], in[8] two recent papers. The inter-relations of the various branches of Science are well brought out in these, for it appears that until a systematist in the Algae can be obtained, the work cannot satisfactorily progress, and that there is hope that ultimately, by changing, through chemical means, the algal flora of any given sheet of water, it will be possible to control the species breeding therein, and thence, malaria. Larval anatomical discoveries by the same author[9] and Iyengar[10] have accorded fresh evidence of the correlation of structure with habits in *Anopheles*. Finally the whole malaria problem in the moist zone of the Eastern Tropics has been fully discussed by Watson.[11]

The ever-increasing Dutch literature on *Anopheles* and malaria cannot be referred to in detail,—such knowledge of it as the Writer possesses has been gained entirely from the *Review of Applied Entomology*, and it is thus as well known to the Members of this Meeting as to him.

Our knowledge of Culicidæ, systematically and bionomically, is likely to undergo large fresh accretions in the near future, owing to the creation since the last Meeting of three fresh posts in connection therewith. Of these, Captain Barraud is engaged under the Indian Research Fund in an all-India mosquito Survey, which has already resulted in numerous discoveries, and the results of which will make the forthcoming *Fauna* volume by Edwards, Christophers and Barraud the most complete of any volume yet issued in the entomological series of this publication. Mr. H. F. Carter, well known for many years past by his work at the Liverpool School of Tropical Medicine, has been appointed Malariologist to the Government of Ceylon, and is engaged on the accumulation and correlation of all the factors relating to the incidence of malaria, whilst the Writer, since his departure from the Pusa staff, has been appointed Malariologist to a Rubber Company, and is engaged in the practical eradication of the disease from the labour forces of its estates. Although the slump in the rubber industry has greatly hampered the progress of the work by lack of the necessary funds, it may be worthy of mention, as illustrating once again the value of what is primarily entomological

research, that on the one estate where the completion of survey work has enabled a scheme of campaign to be devised and put into action, whereas during 1919 the labour force experienced 1.147 separate attacks of the disease, during 1922 only 87 attacks were registered, and after July of that year up to the time of writing, not a single attack of malaria, fresh infection or relapse, has occurred in a force of over two hundred coolies.

The only other family in which great progress has been made is *Muscidæ*. Major Patton,[12-17] in a long series of papers, has published notes on the myiasis-producing forms, descriptions of new species in *Musca* and the *Calliphorinæ,* and much synonomy in these two groups, the results of investigations at the British Museum, mainly into the types of Walker and Bigot. The results of that author's recent tour around the Museums of Europe, in which the types of all the remaining earlier authors were examined, have not yet been published, but the results which Major Patton has from time to time communicated to the Writer, to enable him to keep the Muscid catalogue cards up to date, may be briefly summed up thus, —that Wiedemann, ninety years ago, described practically everything we know by later synonyms ;—hence a complete boulversement of accepted names will shortly result. Of other writers on the family, Bezzi[13] has re-described *M. inferior*, Stein, synonomizing it with *Philæmatomyia gurnei* of Indian literature, and erecting for it a new genus which will share the fate of the one recently erected by Townsend[19] for the Wiedemann species usually known by Awati's recent name of *indica,* by sinking, along with *Philæmatomyia* itself, into Linnæus' *Musca.*

Beyond these two Families, all others have only received *membra disjecta* in the shape of additional new species. Edwards[20] and Carter[21] have described some blood-sucking *Ceratopogoninæ,* Edwards,[22-23] has added quite a number of new Tipulidæ, and given a key to the Old-World species of *Eriocera* which must be used in place of that in the ' Fauna'. Austen[24-25] has described new Tabanidæ from Formosa and has published the determination of a collection from the Punjab. The monographing of the family in '*Genera Insectorum*' by de Surcouf, whilst very valuable, is not of great help to the Indian worker, who has never experienced any difficulty in locating his species generically. The Writer,[26-27] in two short papers, has described new species in several families from Ceylon, the most important of which is a Drosophilid predator of the shot-hole borer of tea.

The early stages of two myiasis-causing Phorids, and the habits of some Oestridæ, with the description of a new Indian species, are among the papers published on other than Muscidæ by Patton,[28-32] who has

recorded yet another unsuccessful series of attempts to elucidate the breeding place of the eye-fly, *Siphunculina funicola*.

In conclusion, it may be useful to make mention of work which may be expected to appear in the near future, before these notes are seen in print, in so far as such is known to the Writer to be in progress.

Brunetti's long overdue third volume in the 'Fauna' series, covering Syrphidæ, Pipunculidæ, Conopidæ and Oestridæ, has I believe, at last gone to press. The same author's second revision of the Oriental Stratiomyidæ is now in the press, and on appearance will completely supersede the 'Fauna' volume on the family.

Edwards will shortly be taking up the Oriental Mycetophilidæ, in which the sub-families will probably be completely re-cast, with much generic re-location and synonomy. The same author has Rhyphidæ in preparation for '*Genera Insectorum.*'

Patton will be publishing much fresh Muscid synonomy, as referred to above, and in collaboration with Major Cragg will shortly complete the second edition of these authors' invaluable *Text Book of Medical Entomology*. In collaboration with the Writer a revision of the Oriental species of the genus *Musca*, with specific keys to both sexes, is nearing completion and this, it is hoped, will put the Indian species of this genus on a firm basis for the future. The Writer has recently described numerous new species in many families in a Pusa Memoir dealing with his tour with the Imperial Entomologist in the Khasi Hills in 1920, mainly representing the new species then discovered, a revision of the Muscidæ Testaceæ of the Oriental Region is in the press, whilst further papers on this Group and on the Rhiniine Muscids have been sent in for publication, as also these families in the Indian Insect Catalogue. Finally, he has the revision of the Indian *Sarcophaginæ* in preparation, the imaginal systematic portion of which is nearing completion.

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31. Patton, Bull. Ent. Res., xii, 243—250.
32. Patton, Ind. Jo. Med. Res., viii, 613—620.

48.—THE GENITALIA OF CERTAIN ANTHOMYIAD FLIES (*ATHERIGONA* SPP.).

By Rao Sahib Y. Ramachandra Rao, M.A., F.E.S., *Act. Government Entomologist, Madras.*

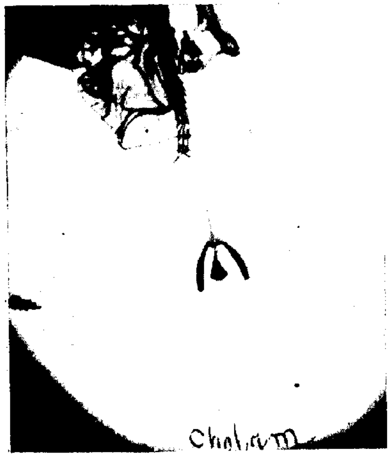
(Plates 31—35.)

Most workers connected with Agricultural Economic Entomology in India are familiar with the occurrence of "Deadhearts" in cereal crops. They are generally caused by the larvæ of the moth-borers, species of *Chilo, Nonagria*, etc., or by beetle grubs, *e.g.*, those of Flea-beetles, but in very young plants "deadhearts" may also be due to "maggots" boring into the central shoot. Such maggots were in the earlier days supposed to be secondary in character, coming in after the primary cause had done its work. Closer observation soon established the fact that such maggots were themselves the primary cause of such "deadhearts." Such maggots were observed in various kinds of cereal crops, especially at Pusa, but the flies reared out looked so much alike and further so much resembled certain flies bred out from rotting fruits and vegetable matter that they were all lumped together as one species. The late Mr. Howlett, in the portion dealing with Diptera in Lefroy's *Indian Insect Life*, wrote about the Rice Stem Fly (wrongly placed by him under Cordyluridæ) thus :—" While the fly frequently does considerable damage to the young rice it is by no means a specific pest of this crop, but has apparently very varied habits. It has been bred from rice, *sorghum*, maize, millets, *cheena* (*Panicum miliaceum*), *sama* (*P. frumentaceum*), celery, *Khira* (*Cucumis sativus*) and brinjal, from wheat, which it damaged considerably in the neighbourhood of Harnai (Baluchistan) 1909, and also from rotten potatoes and decaying vegetable matter of various kinds."

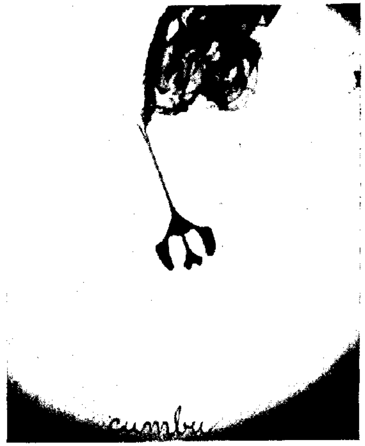
Later work has shown that the flies reared out from the various crops mentioned therein are mostly distinct species.

The writer has been interested in this class of flies since a long time. In 1906, he reared out flies from *Varagu* (*Paspalum scrobiculatum*) at Saidapet and in 1907 reared flies from *Cholam* (*Andropogon sorghum*) and by actual countings found that it was capable of causing about 30 per cent. damage. In 1913, with the construction of an Insectary at Coim-

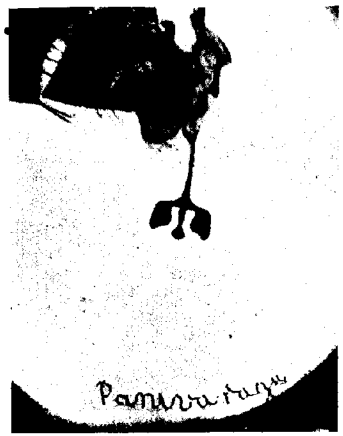
[Note.—Since this paper was sent to the press, descriptions of some of the species of *Atherigona* herein referred to have been published by Mr. J. R. Malloch in *Ann. Mag. Nat. Hist.* (9) XII 177-194 (August 1923). In this paper Mr. Malloch redescribes *A. excisa*, Thoms., and describes as new *A. destructor* (from Coimbatore, larvæ mining shoots of *Panicum miliaceum*), *A. nudiseta* (Coimbatore, Samalkota, larvæ mining shoots of *Panicum stagninum* and *P. frumentaceum*) and *A. indica* (from Coimbatore, larvæ mining shoots of *Andropogon Sorghum*. No. 1 of this paper therefore appears to be *A. indica*, Malloch; No. 7, *A. nudiseta*, Malloch., and *A. destructor*, Malloch, is apparently No. 3 of this Paper.—*Editor.*]

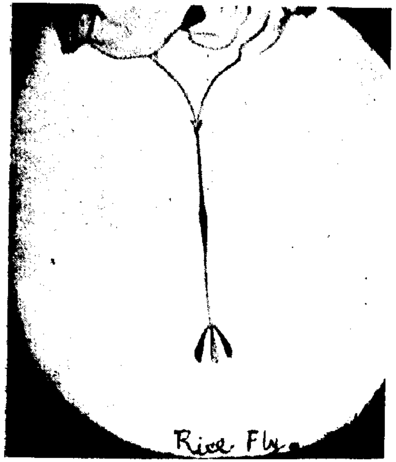


Type I—"Sorghum."

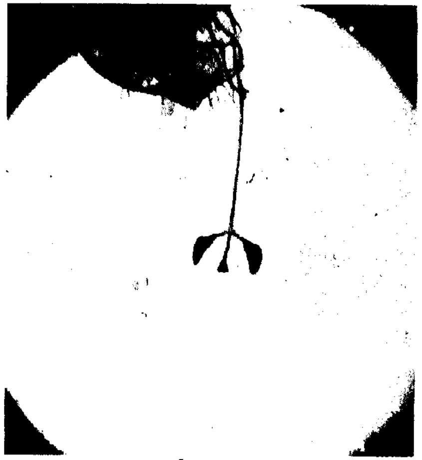


Type II—"Cumbu Fly."



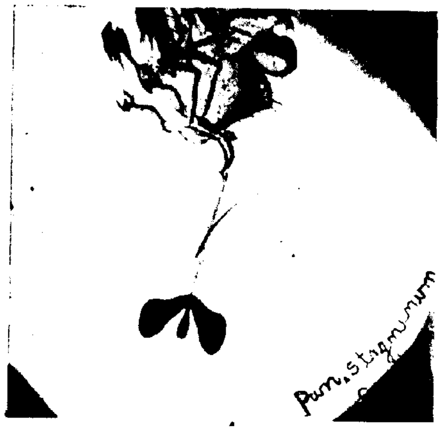


Type IV—" Rice Stem Fly."



Type V—" Kodon Fly."

Type VI—" China Fly."



batore, work was resumed and in 1914 eggs of the "*cholam* fly" were discovered, whereupon in collaboration with Mr. Ballard, Government Entomologist, the life-history was worked out in detail. Early in 1915, a fly breeding in *Cumbu* (*Pennisetum typhoideum*) was discovered and was differentiated from the "*cholam* fly" by differences in the ornamentation of the egg and the armature of the larvæ. Moreover the two flies were found to prefer their own particular food-plants, when both were offered, for laying their eggs. At the same time the fly breeding in rotting or exposed pulp of fruits, such as tomato and watermelon was, by differences noted in these characters, also distinguished and called for the sake of convenience the "Tomato Fly." At this stage work was stopped owing to the absence of Mr. Ballard and the writer on other duty, but specimens of these flies were sent to the Imperial Bureau of Entomology for identification. However, on account of the Great War, the material remained unworked at the British Museum for a long time, till Mr. Malloch, of America, undertook to work it out some time ago when it was transferred to him by the Imperial Bureau.

In 1920 work was resumed and Mr. Ballard discovered the "Rice Stem Fly" at Coimbatore and, in 1921, the writer worked out its life-history. While doing this work, quite by accident he noticed the presence in the male Rice Fly of a very peculiar bristle with a trifoliate tip among the genitalia. With a knowledge of this clue, he made preparations of the abdomens of males of flies reared from various cereals and found to his astonishment that all of them could be separated from one another by this character alone.

In order to assure himself as to whether the form of the bristle was constant in the same series, numerous slides were prepared and examined, and he was satisfied there was very little variation noticeable in flies bred from the same cereal, except in the case of two grasses where further work and closer observations are required.

In February 1922 Mr. Ballard brought from Pusa two boxes full of Anthomyiads from the Pusa Collection, which Mr. T. Bainbrigge Fletcher, Imperial Entomologist, Pusa, kindly placed at the disposal of the writer for working out the specific differences. This collection was all the more valuable, as it consisted mostly of reared material and contained in some instances specimens collected from distant parts of the Indian Empire. As a result of the examination of genitalia of those series where males were available, many of the types of genital bristles found at Coimbatore were also noted at Pusa, and in addition one type at least was noted which has not been noticeable in the South.

From a perusal of the article by Hackett in the *Transactions of the Entomological Society of America*, Vol. XIV No. 4, on the usefulness of

the ovipositor in distinguishing species, an examination of the ovipositors of many of these species was made and, as a result, it has been found to be to some extent possible to distinguish species by the varied development of certain striking landmarks noticeable in this structure.

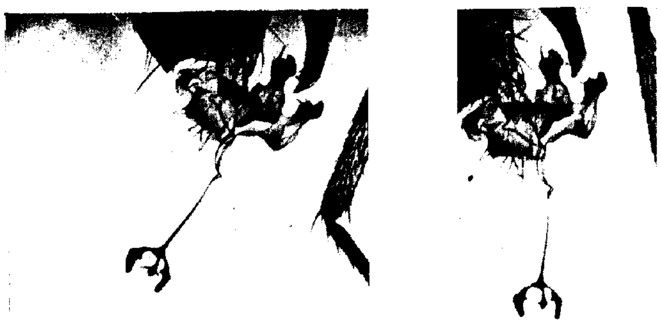
In spite of the interesting results obtained by the writer, on account of the non-availability of literature on the subject and of types for comparison and a lack of intimate acquaintance with other groups of Diptera, he felt it very difficult to undertake to describe the species. He has therefore sent up numerous series of flies from the Coimbatore and Pusa Collections to Mr. J. R. Malloch of the Biological Survey, U. S. Department of Agriculture, Washington, who has kindly undertaken to work out the collection. Mr. Malloch places all the species breeding in cereals in the genus *Atherigona*, Rondani, while the flies breeding in rotting fruit are identified provisionally as *Acritochæta* (sub-genus of *Atherigona*) *excisa*, Thom. (*pulvinata* Grimshaw). He also states that he has noted the trifoliate structures of the males and has drawn most of them for a manuscript paper which has been ready for publication for some time past.

The male genitalia.—A perfect knowledge of the genitalia of insects is in itself a life-study and the writer does not presume to have such a knowledge, but from a perusal of Metcalf's article on the "Genitalia of Male Syrphidæ" in the *Ann. of the Ent. Soc. of America*, Vol. XIV No. 3, and Walter Wesché's article on the "Genitalia of both the sexes in Diptera" (*Tran. Linn. Soc., London*, Ser. II, Zool., Vol. IX; 1906), a general idea of the complicated structures one meets with at the tail-end of the abdomen in male specimens of *Atherigona* spp. may be formed.

The visible segments in the abdomen of a male in a flexed condition are segments 3, 4, 5, and 6 of the hypothetical male. Segments 7 to 10 are modified into genitalia. When the genitalia are unfolded it is seen that the ventral surface of segments 4 (in part), 5 and 6 are invaginated to form a genital pouch in which the genitalia are folded when not in use. The genitalia, which are modifications of the appendages of segment 7 to 10, consist of (1) a dorsal process with a bifid tip, probably modified cerci ? (found only in *Atherigona*), (2) a hairy hypopygium carrying at the apex in *Atherigona* a bristle of varying length with a trifoliate tip, (3) the claspers ("Styles" of Metcalf), and (4) a median unpaired jointed appendage, the penis. All these structures when folded into the genital pouch are kept in position by clasper-like modifications on the ventral face of segments 4 and 5.

A comparison of the genitalia of the various species of *Atherigona* shows that all these structures assume characteristic shapes in each, but the most distinctive of all was found to be the hypopygial bristle. In prepared specimens the base of the bristle is seen to bifurcate and become

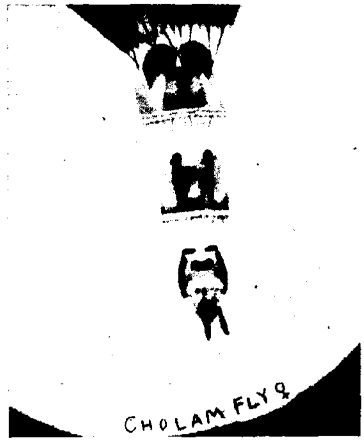
Type VIII—" Sindh wheat-stem Fly " ; left, bred from wheat-stem at Mirpurkhas ; right, fly caught in Botanic Garden at Lahore.



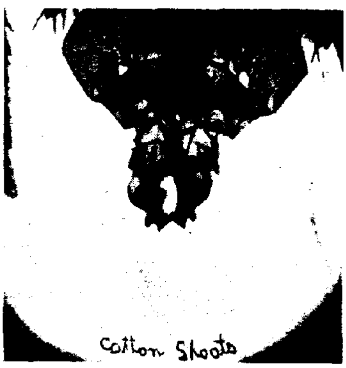
Type IX—" Coimbatore wheat-stem Fly."

A new type? Fly bred from *Setaria italica* at Coimbatore.

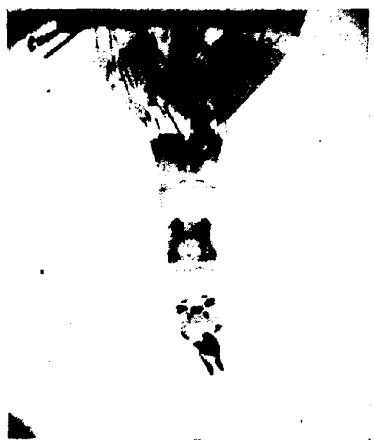
A new type? Fly bred from *Isachne australis* at Coimbatore.



Ovipositor of Type I—"Sorghum Fly."



Type X—"Tomato Fly."
(*Acritochaeta excisa*, Thoms.)



Ovipositor of Type II—"Cumbu Fly."

Genitalia of certain Anthomyiad Flies.

merged in the hypopygial skeleton. The bristle consists of a stem which may be long or short, uniformly thin or expanded in the middle. The trifoliate tip consists of two wings which may be thin and narrow, or expanded leaf-like, or provided with small expansions on the inner face. The central member or tongue also assumes distinctive forms. It may be thin and slightly expanded at the tip, or foliate throughout; the tip may be bifid, square or semi-circular. In all cases the tip is provided with small spines, the arrangement of which varies in different species but is uniform in individuals of the same species. Photomicrographs of the various forms of genitalia herewith attached will explain themselves better than any detailed description. (Plates 31-34).

In *Acritochæta*, the bristle is absent but is replaced by a sessile chitinisation of the hypopygium (?) and the cerci (?) appear to be absent.

Observations on the modes of courtship among *Atherigona*-spp. especially the "*cholam* fly" and "the Rice Stem Fly," showed that the genital bristle was used by the male in paying court to his bride. The usual posture was for the male to seat himself at right angles to the females, the head almost touching her wings. His wings quivering with passion, he rubbed her wings with his proboscis and at the same time bent his abdomen sideways, unfolded the bristle and flourished it gently before her face, almost touching her with it. After pursuing these manœuvres for some time, he generally tried to seize her and pair, but with varying success.

The differentiated forms (species ?). As separated by the shape of the genital bristle, the following forms have been distinguished among flies in the Coimbatore and Pusa collections.

(1) *Atherigona (sorghum)*; "*Cholam* Fly." Inter-orbital space dark brown. *Food-plants—Andropogon sorghum*, Sudan Grass (*And. Sorgh*) and *Andropogon sp.* (Baghdad).

Distribution.—Coimbatore, Surat, Poona, Nagpur, Akola, Pusa, Sasalu (Mysore) and Baghdad (Iraq).

Years of collection of specimens. 1908—1922.

(2) *Atherigona (Cumbu-Pennisetum)*; "Cumbu Fly." (Inter-orbital space, yellow-brown). *Food plants. Pennisetum typhoideum.*

Distribution. Coimbatore.

Years of collection. 1915—1922.

(3) *Atherigona (Panivaragu—Panicum miliaceum)*; "*Panivaragu* Fly." (Inter-orbital space yellow-brown).

Food plants. Panicum miliaceum (T. Pani-varagu), Panicum miliare (T. Samai), Eriochola (?) (Coimbatore), *Setaria italica (Tenai), Panicum frumentaceum* (?) (Hubli; collected by H. Maxwell Lefroy; 1903).

Distribution. Coimbatore, Hubli, Cherambadi (Wynaad).

Years of collection. 1903—1922.

(4) *Atherigona* (*Oryza sativa*); "Rice Stem Fly." (Inter-orbital space dark brown).

Food plants. Oryza sativa, Wheat (spelt wheat of Coimbatore), *Setaria italica* (?).

Distribution.—Coimbatore, Cherambadi (Wynaad), Pusa, as determined from female specimens.

Years of collection. 1913-22.

(5) *Atherigona* (*Paspalum*)—"*Varagu* Fly" or *Kodom* Fly. (Inter-orbital space dark brown).

Food plants.—Paspalum scrobiculatum (Tamil) *Varagu,* (Hind) *Kodon ; Paspalum scrobiculatum* (Wild variety); *Isachna* (?), (a grass); *Eriochloa* (?) (Coimbatore).

Distribution. Pusa, Coimbatore, Saidapet, Manganallur (Tanjore) Cherambadi (Wynaad).

Years of collection. 1906—1922.

(6) *Atherigona* (*China*); "*China* Fly" (Inter-orbital space yellowish).

Food plants. Panicum miliaceum (Pusa; 1906—1922); *Setaria* (?), *Isachne* (?). (Coimbatore).

Distribution. Pusa; Coimbatore (?) (rather doubtful).

(7) *Atherigona* (*Pan. frumentaceum*); "*Kudiraivali* Fly." The largest of the species noted. (Inter-orbital space snuff-brown).

Food-plants. Pan. frumentaceum (Kudiraivali); *Pan. stagninum* (a grass).

Distribution. Coimbatore, Samalkota, Pusa.

Years of collection. 1918—1922.

(8) *Atherigona* (Sindh) (Sind wheat-stem fly). (Inter-orbital space yellow-brown).

Food plants. One from Mirpurkhas (Sindh) on wheat.

Distribution. Only two males. One from Mirpurkhas and the other caught from Lahore. (The females reared from wheat were from Peshawar).

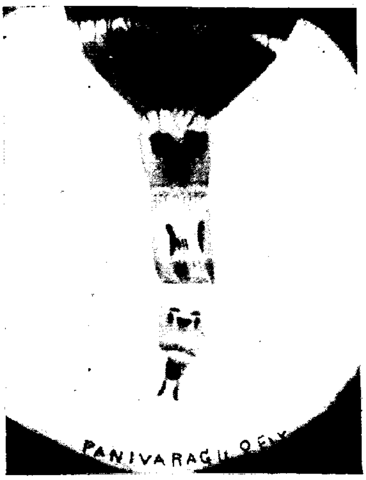
Years of collection. 1913—1918.

(9) *Atherigona* (Coimbatore wheat). (Coimbatore wheat-stem fly). (Inter-orbital space dark brown).

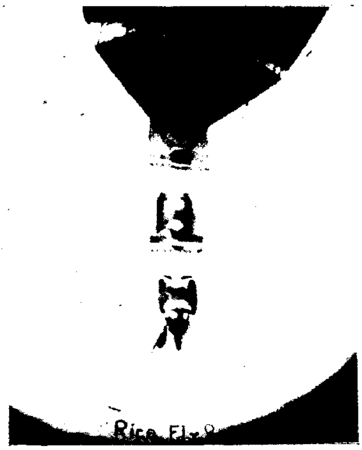
Food plants. A grass near Pusa river, F.M.H., 1909; Wheat, Coimbatore, 1922.

Distribution. Pusa, Coimbatore.

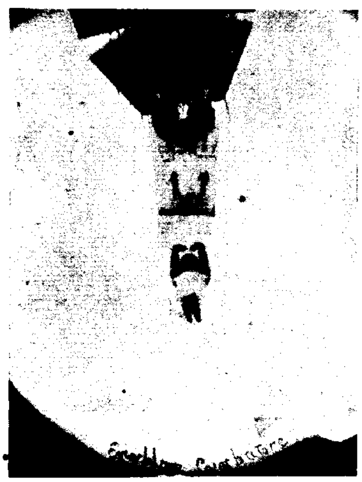
(10) *Acritochæta excisa.—Food records.* Rotten tobacco stems, orange fruit, *Kanhra* stem (Pusa), *Chichura* (?), *Gheura ?* (Pusa), rotting gourd, rotting cotton shoots, watermelon,



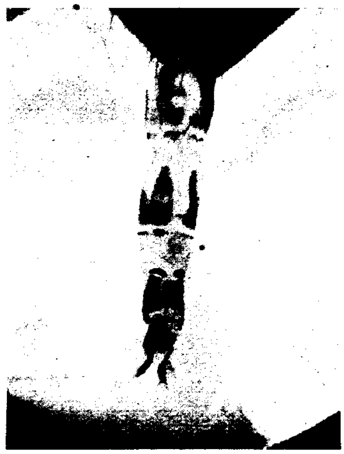
Type III—" Panivaragu Fly " from *Panicum milaceum.*



Type IV—" Rice-stem Fly."



Type V (?)—*Paspalum ?*



Type VII—" Kudiraivali Fly " from *Panicum frumentaceum.*

Ovipositors of certain Anthomyiad Flies.

maize, *juar* head, rotting fruits, rotting cotton bolls, *Cucumis melo*, rotting pepper, ripe figs. rotten tomato fruits, rotten pomegranate.

Distribution. Rangpur, Darjiling, Chindwara, Pusa, Calcutta, Peshawar, Coimbatore, Yercaud, Maddur (Mysore) Surat, Taliparamba, Samalkota, Baghdad (Mesopotamia).

Years of collection. 1907—1922.

Ovipositor. In many of the more common species preparations of the ovipositors were made and studied. When extended, the ovipositor is found to be composed of 4 segments — segments, 6, 7, 8 and 9 of the hypothetical female according to Hackett (Morphology of the ovipositor of certain Anthomyian genera, *Annals of the Ent. Soc. of America*, Vol. XIV No. 4). The segments are found to be made up of a hard or chitinized portion and a membranous intersegment which allows of the ovipositor being retracted telescopically when at rest. The chitinized segment is not a tube of uniform thickness, but is composed of the tergum and the sternum which are chitinized in varying degrees. In the chitinized portion there are certain parts which are more highly chitinized in serving probably as attachments to muscles and the shape and arrangement of these form distinctive marks for separating different species. As far as examined, the ovipositors of the same species exhibit the same type of arrangement. Further work is needed before one can utilize these structures for taxonomic work.

Mr. Fletcher. I had the pleasure of seeing some of the slides while they were under preparation at Coimbatore. The genital armatures are very striking structures and it is difficult to imagine what specific purpose they serve. From the point of view of Systematics these structures afford a very interesting subject for study.

Mr. Ramachand Rao. These structures play a part in the courting habit of the flies. The male insect places himself at right angles to the body of the female and strokes her wings with his proboscis, his own wings meanwhile quivering with passion. The genital armature is then exserted, and by a turn of the abdomen is waved about in front of the face of this female.

Mr. Fletcher. Here in India we have many species of insects which, so far as superficial characters are concerned, appear identical with foreign species. In such cases, the comparison of the genitalia is very important as it may show that the species are really distinct.

Such work affords another instance of the great importance of systematics in Economic Entomology. It is a very pretty piece of systematic study but has a distinct practical application in serving to distinguish superficially similar insects from different host plants.

49.—ON THE NEED OF A MORE CAREFUL STUDY OF THE GENUS *MONOPHLEBUS*, IN INDIA.

By E. ERNEST GREEN, F.E.S., F.Z.S.

This short note is inspired by the receipt of a most interesting memoir * by Prof. S. I. Kuwana, on three species that occur in Japan.

Incidentally, this author, having regard to the somewhat conflicting views upon the status of the name *Monophlebus*, cuts the Gordian knot by erecting a completely new genus (*Warajicoccus*) for the reception of his Japanese species. The type of the genus *Monophlebus*, (*atripennis*, Burm.), consists of a male—unassociated with any recognized female. Burmeister's description of this insect (" Black, the abdomen, scutellum and base of wings obscurely flesh-coloured......... ; wings pitchy, with two hyaline white lines ; abdomen......... terminating in two hairy, fleshy appendages " would fit, equally well, the male of a *Walkeriana*, or *Aspidoproctus*, or even of a large *Icerya*. If, however, the name *Monophlebus* should be rejected for our large Oriental species, they would fall naturally into *Drosicha* of Walker, which comes next on the priority list, and of which the type specimen (a female) is available for study.

But, apart from the question of nomenclature, Kuwana's methods might be followed, with great advantage, by students in India where abundant living material is available. He has worked out the complete life-history of three distinct but closely allied species and has found good distinguishing characters even in the newly hatched larvæ. Prof. Kuwana has ascertained, by careful observation, both in the field and in the laboratory, that—for all three species—a complete life-cycle occupies just twelve months, eggs being deposited in May and June of one year, the females reaching the adult stage during the same months of the following year.

He has shown that there are five stages in the life-cycle of the female, *viz.*—egg, 1st stage nymph (or larva), 2nd stage nymph, 3rd stage nymph, adult. During the same period the males pass through six stages :—egg, 1st stage nymph (or larva), 2nd stage nymph, pre-pupa, pupa, adult.

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* " Studies on Japanese *Monophlebinæ*: The Genus *Warajicoccus*." Bulletin of the Imperial Quarantine Station, Yokohama. Aug. 1922.

An accurate determination of the life-cycle of our Indian species, and a careful study of the minute characters of all the separate stages, is most important for the correct identification of the species. The following points should receive particular attention :—

Eggs. Colour ; dimensions ; duration of stage.

1st stage nymph. Colour ; dimensions ; number and relative size of antennal joints ; disposition and character of body setæ ; structure of dermal pores ; characters of anal orifice and the surrounding area.

2nd and 3rd stage nymphs. Colour ; number and relative size of antennal joints ; disposition of body setæ ; structure of dermal pores.

Adult female. Colour and markings ; dimensions of fully developed insect, immediately before oviposition ; number and relative size of antennal joints ; characters of labium, limbs, thoracic and abdominal spiracles and anal orifice ; characters of derm of both dorsum and venter, with special reference to the setæ, pores and dermal cells. (The structural characters of the dorsum and venter are often very different—the one from the other. To study these satisfactorily it is necessary that the dorsum and venter should be mounted separately. To effect this, the freshly killed insect should be sectioned, with a pair of finely pointed scissors, around the margin. When subsequently the insect is boiled in potash, the two halves will come apart and may be mounted, side by side, on the same slide).

It is advisable that all these details should be tabulated in a definite order, for convenience of comparison.

As an example of the unreliability of superficial resemblances, I must draw attention to an unfortunate misidentification in Part V of my *Coccidæ of Ceylon*.

At the time of writing up the genus *Monophlebus*, the type (and only example) of Walker's *contrahens* was represented in the British Museum of Natural History by a dried and pinned specimen. The superficial appearance of this specimen was so exactly similar to that of examples of *Monophlebus* in my collection from Ceylon that—coupled with the fact that Signoret had recorded and described examples from Ceylon, under the name of *contrahens*—I was satisfied that my specimens were really referable to that species and described them accordingly. Since the publication of that description the Museum Authorities have permitted the unique type of *contrahens* to be prepared and mounted for microscopic study. Examination of this preparation revealed the fact that my Ceylon insect was quite distinct. It will therefore require a new name. I am redescribing it, elsewhere, under the name of *phyllanthi*. It is sharply separated from *contrahens* and all but one of the named Indian species by the structure of the abdominal spiracles. In *phyllanthi* the

outer chamber (for which I propose the term "atrium") of each abdominal spiracle is crowded with multilocular pores (*vide Mon. Cocc. Ceyl.*, V, t. CLXXVI, fig. 9). This condition occurs in *tamarindus* also; but that species is sufficiently differentiated from *phyllanthi* by the very minute and slender setæ that clothe the dorsum, the dorsal setæ of *phyllanthi* being much stouter and longer.

I have been unable to associate *contrahens* with any of the remaining Indian species (*stebbingi, dalbergiæ* and *octocaudatus*).

The following tentative synopsis of the characters of the females may be useful:—

A. Atrium of abdominal spiracles crowded with multilocular pores.
- (*a*) Dorsal setæ long and stout . . *phyllanthi.*
- (*b*) Dorsal setæ minute and slender . . *tamarindus.*

B. Atrium of abdominal spiracles without multilocular pores.
- (*a*) Dorsal setæ minute and slender . . *stebbingi.*
- (*b*) Dorsal setæ long and moderately stout *octocaudatus* and *dalbergiæ.*

I have not yet been able to find satisfactory characters to differentiate the females of *octocaudata* and *dalbergiæ*; but the males of these two species may be distinguished by their size and by the character of the abdominal tassels, *viz.*:—

- (*aa*) Expanse of wings 10 to 13 mm.; 4 pairs of abdominal tassels, the uppermost very short . . . . *octocaudatus.*
- (*bb*) Expanse of wings 13 to 16 mm.; 4 pairs of abdominal tassels, the uppermost elongated. (Occasionally with a fifth, very short tassel, on the preceding segment) . . . . *dalbergiæ.*

Mon. phyllanthi occurs in India also. I have examples from the Sukkur Forest, on *Tamarix* (coll. J. H. Irani); from Samalkota, on *Croton* (coll. T. V. Ramakrishna Aiyer); from Multan, on *Gossypium* (coll. U. Bahadur); from Bangalore and Calcutta, (ex coll. Ind. Mus.).

Of *tamarindus* I have material from Agra, on Tamarind (ex coll. Bombay Nat. Hist. Soc.); from Calcutta, on *Prosopis spicigera* (ex coll. Ind. Mus.)

I received *stebbingi* from Dehra Dun, on *Shorea robusta* (coll. E. P. Stebbing).

I have *octocaudatus* from Lahore, on Mango (coll. E. P. Stebbing) from Pusa, on "a creeper" and on Peach tree (ex coll. T. B. Fletcher); and from the same locality, on *Alstonia* (ex coll. Ind. Mus.).

The remaining species, *dalbergiæ*, was received from the Sutlej Valley, on *Dalbergia sissoo* (coll. E. P. Stebbing). I have also a doubtfully determined male of this species from Pusa.

50.—A FURTHER CONTRIBUTION TO OUR KNOWLEDGE OF SOUTH INDIAN COCCIDÆ.

By T. V. RAMAKRISHNA AYYAR, B.A., F.E.S., *Assist. Entomologist, Madras.*

In an earlier paper on South Indian Coccidæ which was published in 1919 an annotated list of the Coccidæ then known from South India was given. In this paper, which is intended to be a supplement to the previous one, I have included as briefly as possible the results of the study of the Coccid fauna of South India which has been continued since 1919. In the earlier publication 129 South Indian species were recorded with brief notes on whatever was then known of the bionomics of each. As a result of further collection and study not only has some additional information been gathered on the already known forms, but 33 new records, including 22 forms new to science, have also been added. The object of this paper is to bring our knowledge of this family of South Indian insects as up-to-date as possible.

Though some substantial addition has been made to the previous knowledge of this group during the past two years, many tracts in the Province still remain unexplored, especially the Hill tracts which are sure to contain many more new forms. That there still exist many undiscovered novelties may be gathered from the fact that, during one collecting trip in the Tinnevelly Hills in July 1921, I was able to secure nine new species besides additional data on known forms.

I have here again to express my gratitude to the eminent Coccidologist, Mr. E. E. Green, for his continued help in my studies.

In the following list those with an asterisk are either new species or those recorded for the first time from South India.

Chionaspis, Sign.

C. dilatata, Green	On *Clinogyne virgata*, Chandanathode, Wynaad (October); on Coconut husk received from Singapore.
C. varicosa, Green	On *Gelonium lanceolatum*, Mundanthorai, Tinnevelly (July).
C. herbæ, Green *	On Grass; Coonoor(August). This is a new record for India. First noted by Green in Pundaluoya (Ceylon) on grasses.
C. spiculata, Green	This new species given under a MS. name in my bulletin has since been described by Green in the Records of the *Indian Museum*, XVI, p. 437 (1919).
C. decurbata, Green	On Grass, Malabar (May).
C. graminis, Green	On *Andropogon nardus*, Wynaad, Malabar. (October).
C. acuminata-atricolor, Green	On *Ficus retusa*. Coimbatore.

Hemichionaspis, Cockerell (Pinnaspis.)

H. aspidistræ, Sign.	On *Areca* leaves, Kallar, Nilgiris (October).
H. minor, Msk.	On dry pumpkin vines, Podalada, Kistna Dt. (February). On *Sida*, Peermade, Travancore (P. V. I: Coll). On cotton, Sivagiri, Ramnad Dt. (June).
H. bauhiniæ, Green (MS).)*	On *Bauhinia racemosa*, Papanasam, Tinnevelly (July); the foliage was badly infested; also in Walayar forests on same plant (May).
H. chionaspiformis, Newst., *var.*	On *Tephrosia purpurea*, Sivalapperi, Tinnevelly (July).

Fiorinia, Targ.

Fiorinia plana, Green	Mr. Greens' description of this insect has appeared in the *Records of Indian Museum* XVI, p. 447 (1919). Noted again on *Elæodendron glaucum*, Courtallum, Tinnevelly. (November).
F. fenestrata, Green Ms.*	On *Elæocarpus ;* Nilgiris (6,000 ft.). (May).

Aspidiotus, Bouche.

A. destructor, Sign	On coconut foliage, Tanuku, Kistna Dt. (February). On *Gelonium lanceolatum*, Mundanthorai, Tinnevelly. (July).
A. orientalis, N.	In addition to the numerous food plants already noted in the bulletin, the insect has been found on *Hygrophila spinosa*. Podalada, Kistna Dt. (February), and on *Limonia alata*, Mundanthorai, Tinnevelly. (July).
A. lataniæ, Sign.	Similar to the previous species, this scale has also been noted on many other plants besides those noted in my bulletin :— On rain tree, Coimbatore. (April). On Apple shoots, Yercaud. (May) On Grape shoots, Coimbatore. (April). On Tea, Coimbatore. (August). On *Ficus indicus*, Kollegal. (April). On *Sapota* shoots, Coimbatore. (March).
A. dictyospermi, Morgan	On Mango leaves. Sivalapperi (Tinnevelly). (July). Not recorded from India before.
A. aurantii, Msk.	Bad on *Morinda tinctoria*, giving the leaves an almost uniform pink hue; Udipi (S. Kanara). (May). I have not yet seen this notorious pest of Citrus on any *Citrus* varieties in South India so far.
A. calophylli, Gr. var. *symplocos* Green (MS.).*	On *Symplocos* leaves ; Nilgiris (6,000 ft). (May).
A. tripinnatus, Green, MS.*	On *Callistemon* leaves, badly infested, Coonoor (Nilgiris 5,000 ft.). (May).
A. pseudocamelliæ, Green, and *A. tamarindi*, Green.	These two new species have since been described by Green in the *Records of the Indian Museum*, XVI, p. 438 (1919).
A. hartii, Cockerell.*	On turmeric rhizomes and on yam tuber, Coimbatore, June. There is a previous Indian record of this from Poona by Kassergode (*Bombay Journal*) on *Curcuma longa*.

A. longispinus Morgan * .	. On *Bauhinia racemosa*, Papanasam (Tinnevelly). (July). This is the first record for India. Green has noted it in Ceylon on Jak tree bark (see *B.J.* XVI, p. 340 (1905).
A. ficus, Ashmead .	. On *Citrus* leaves, Madura (April).
A. trilobitiformis, Green .	. On *Gelonium lanceolatum*, Mundanthorai (Tinnevelly) (July).
A. pinnulifera, Mask-var. *diversicolor*, Green.*	On orchid (*Cymbidium*); Nilgiris (8,000 ft.) (in glass house). First record for India.

Diaspis, Costa.

D. orientalis, Green Ms.*	. On *Hemigyrosa*, Courtallum and Mundanthorai (Tinnevelly) (July and November).
D. barbatus, Green Ms.* .	. On *Ischaemum hirtum*, Sengelteri (Tinnevelly) (July). It was found in company with a new species of *Aclerda*. (See below).
D. rosæ, Sandb. . .	. On Loranthus (Coonoor, Nilgiris, 6,000 ft.).
D. mangifera, Green. .	. On mango, Sivalapperi (Tinnevelly) (July).
D. boisduvali, Sign.* .	. On orchid (*Cattleya*). Nilgiris 8,000 ft. in glass house First record for India.

Aonidia, Targ.

Aonidia tentaculata, Green.	. The description of this species has appeared on page 440 in the *Records of the Indian Museum*. Vol. XV. (1919).

Gymnaspis, Newst.

G. ficus and *G. ramakrishnæ*	. Green's descriptions of these species, mentioned in my Bulletin, are found in the *Records of the Indian Museum*, XVI, pp. 441 and 442 (1919).
G. diospyros, Green, MS.*	. On *Diospyros embryopteris*, Mundanthorai (Tinnevelly) (July).
G. producta, Green MS.* .	. On *Diospyros embryopteris*, Mundanthorai (Tinnevelly) (July).
G. affinis, Green MS.* .	. On *Ficus bengalensis*, Sivalapperi (Tinnevelly) (July).
G. mangifera, Green MS.*	. On mango leaves. Sivalapperi (Tinnevelly) (July). This species differs from *G. ramakrishnæ*, Green, in the more prominent pygidial lobes and in the presence of a fimbriated fringe surrounding the insect's body.

Lepidosaphes (Mytilaspis), Shim.

L. albizziæ, Green MS.* .	. On *Albizzia lebbek*, Coimbatore.
L. piperis, Green. . .	. On pepper vines, Travancore and Wynaad (November).
L. leucophlææ, Green MS.*	. On stem and shoots of *Acacia leucophlæa*, Coimbatore (August).
L. meliæ, Green and *L. retrusus*, Green.	These two scales, recorded with manuscript names in my Bulletin, have been described by Green in the Records of the Indian Museum, XVI, pp. 445 and 446 (1919).
L. punctatissima, Green MS.	. On *Albizzia lebbek*, Coimbatore.
L. punicæ, Green (MS).* .	. On Pomegranate, Coimbatore (June).

Parlatoria, Targ.

P. camelliæ, Comstock.* . . On *Melia* stem with *Lephidosaphes meliæ* (March). No previous record from India. On *Aegle Marmelos*, Coimbatore.

P. cristifera, Green, MS.* . On *Citrus* leaves, Maddur (Mysore) (September).

P. limoniæ, Green MS.* . . On *Limonia alata*, Mundanthorai (Tinnevelly) (July).

P. pergandii, Comst. .. . On *Limonia alata*. Mundanthorai (Tinnevelly) (July).

P. vateriæ and *P. papillosa* . These two new species, recorded under MS. names in my Bulletin, have been described by Green in the Records of the Indian Museum, XVI, pp. 444 and 443 (1919).

Pulvinaria, Targ.

P. psidii, Msk. . . . . On *Nux vomica* leaves, Cuddappah (November); on *Carissa carandas* Coimbatore (March); on *Ficus retusa*, Kollegal (January).

P. maxima, Green . . . On *Jatropha curcas*, Podalada (Kistna Dt.) (February); on *Zizyphus jujuba*, Coimbatore (July); on *Coccinea indica*, Coimbatore (February).

Ceroplastes, Gray.

C. actiniformis, Green . . On *Alstonia scholaris*, Coimbatore (April).

C. floridensis, Comst. . . On Guava, Perur (Coimbatore) (March).

Inglisia, Mask.

I. bivalvata, Msk. . . . On *Pongamia glabra* shoots, Coimbatore (March). Shoots and stems of isolated young plants were found very badly infested.

Ceroplastodes, Ckll.

C. cajani, Msk. . . . . On *Tephrosia candida* (April), Mooply Valley (Cochin) (Farm Manager coll.)

Lecanium, Burm.

L. nigrum, N. . . . . In addition to the many food plants noted before, the insect has been noted on *Justicia*, *Morinda*, and *Luffa* in Coimbatore.

L. hemisphericum var. *filicum*, Bdv. On garden fern, Bangalore (April).

L. hesperidum, L. . . . In my Bulletin I have made a mistake by stating that this species has not been recorded from India before. It is recorded from Pusa (Pusa Memoir II, p. 30) as being found in association with the red ant, *Occophylla*, on a tree.

L. oleæ, Bern . . . . On red-gram shoots, Kotipalli (Godavari) (January); on *Odina wodier*, Coimbatore (May); on *Sapota* flower-stalks, Coimbatore (March).

L. longulum, Douglas . . On *Excocaria agallocha*, Cocanada (Godavari) (April). On Red gram, Kotipalli (Godavari) (January).

L. ramakrishnæ, Green MS.	This is recorded from Northern India on Pear, Kulu valley (p. 19, *Proceedings of 4th Entomological Meeting*, 1921).
L. mangiferæ, Green.*	On mango leaves, Coimbatore. First record for India.
L. acutissimum, Green	On Jak leaves, Coimbatore (March).
L. discrepans, Green	On *Citrus* leaves, Mundakayam (Travancore) (April).
L. bicruciatum, Green.*	On Mango, Sivallapperi (Tinnevelly) (July). This is the first record for India. Previously recorded by Green from Peradenyia on *Eugenia*, *Calophyllum*, etc.

Cribrolecanium (Green).

(P. 640, *A.M.N.H.*, December 1921).

C. radicicola, Green*	On roots of *Acacia auriculiformis* under the soil, Coimbatore (March).

Aclerda, Sign.

A. ischæmi, Green MS.*	On *Ischæmum hirtum*, growing along the side of a hill stream, Singelteri (Tinnevelly) (July).

Pseudococcus, Westwood.

P. filamentosus, Ckll. ; *corymbatus*, Green.	On *Melochia*, Manganallur (Tanjore) (March), Green states his *corymbatus* is the same as *filamentosus*, Ckll.
P. crotonis, Green	This is a synonym for *P. lilacinus*, Ckll. On tamarind, Coimbatore (May). See page 35, Vol. VI, *Journal of Ec. Biology* (1911) for Green's description of this species.
P. bromeliæ, Bouche *	On Pine-apple fruits, at the proximal portions of the fruits ,Taliparamba (N. Malabar) (September).
P. detorquens, Green MS.*	On Bamboo shoots, Walayar Forests (Malabar) (May).

Phenacoccus, Cockll.

P. insolitus, Green	On a wild plant, Taliparamba (September).
P. mangiferæ, Green	On *Eugenia hemisphærica*, Singelteri (Tinnevelly) (July). Green thinks *P. ballardi*, is Newst., the same as this species.
P. iceryoides, Green	On *Plectronia parviflora*, Singelteri (Tinnevelly) (July); on *Ficus indicus*, Kollegal (January); on *Pithecolobium saman* (Rain tree), Coimbatore (March): on cotton shoots, Coimbatore (March); on *Dolichos lablab*, Coimbatore (March).
P. hirsutus, Green*	On *Ficus* leaf, Kollegal (Coimbatore) (September). Originally described by Green, p. 25, *Pusa Memoirs*, Vol. II.

Antonina, Sign.

A. indica, Green	On grass roots, Coimbatore (April). First described by Green (p. 27, *Pusa Memoir*, II (1908)) on *Harial* grass in Bengal.

Anomalococcus, Green.

A. indicus, Green, MS.* .	. On *Acacia leucophlœa*, Bangalore (January).
A. hirsutus, Green, MS.* .	. On a wild tree, Singelteri (Tinnevelly) (July).

Cerococcus, Comst.

C. hibisci, Green . .	. On cotton; Golgonda (Ganjam) (April) and Sivagiri (Ramnad) (June); on *Tephrosia Candida*, Western Ghat (Cochin) (May).

Eriococcus, Targ.

E. lagerstrœmiæ, Kuw. .	. On *Anogeissus latifolia*, Singelteri (Tinnevelly) (July).

Tachardia, Blanch.

T. lacca, Ker. . .	. On Rain tree, Coimbatore (April); on *Butea frondosa*, Coimbatore (March); on *Shorea talura*, Mysore (September).
T. minuta, Morrison .	. On Pomegranate, Coimbatore, probably same as Green's *lobata*.

Aspidoproctus (Walkeriana), Sign.

A. xyliæ, Green, MS.* .	. On *Xylia* stem, Taliparamba (Malabar) (October).
A. cinerea, Green . .	. On Pomegranate, Coimbatore (October); on *Anogeissus latifolia*; Singelteri (Tinnevelly) (July).
Labioproctus (Walkeriana) polei, Green.*	On *Citrus*, Coimbatore (March). First record for South India.

Icerya, Sign.

I. ægyptiaca, Dougl. . .	. On croton, Kollegal (January); on *Trewia*, Coimbatore (May); on *Asystasia Chelonoides*, Singelteri (Tinnevelly) (July).

Orthezia, Bosc.

O. insignis, Dougl. . .	. Reported on *Lantana* from Wynaad in May 1920.

Monophlebus, Burm.

M. phyllanthi, Green * .	. On *Cleistanthus collinus* and *Bauhinia*, Walayar Forest Malabar) (May).

51.—A LIST OF COCCIDÆ IN THE PUSA COLLECTION.

By Rai Bahadur C. S. MISRA, B.A., *First Assistant to the Imperial Entomologist.*

The object of giving a list of Coccidæ in the collections at Pusa has been to draw the attention of the collectors and workers in Coccidæ to the existence of the species at Pusa with their alternative food-plants and distribution. From a perusal of the records, it will be seen that more intensive collection is required so as to make the list of food-plants and distribution more complete. The collection of the material began in 1907 and it was not until October 1915 that the first lot was identified by Mr. E. E. Green. Subsequent lots were identified by Mr. F. Laing of the Bureau of Entomology. A very large mass of material is still awaiting identification, and as soon as sufficient *data* have been accumulated regarding food plants and distribution these will be sent for identification. From the accompanying it will also be seen how some of the most destructive species such as:—*Aspidiotus perniciosus*, Comst., *Diaspis* (*Aulacaspis*) *pentagona*, T. T., *Diaspis echinocacti*, Bouché, *Parlatoria pergandei* var. *camelliæ*, Comst., have got into the country along with imported fruit trees and other plants. *Aspidiotus aonidum* is gradually being introduced into the country on imported oranges from Egypt, where serious efforts are being made now by the Entomological Department to keep the pest in check. The loss that has already been done by introduced insects such as *Eriosoma* (*Schizoneura*) *lanigera*, Hausmann, has already been described by me.* But now comes into prominence the damage that is being done in Kashmir by two pests (*Eriosoma lanigera* and *Aspidiotus perniciosus*) conjointly. Practically all the apples, pear, cherry, apricot, nectarines, etc., are affected by one or other of the fruit pests, and it will require no little trouble and expenditure to bring them under control. An intensive collection of scale insects will bring to light the distribution and food plants of other destructive species which have hitherto escaped detection and collection. All that is required to do is to cut off the infested leaf, bud, twig or root with a knife and to put the specimens separately into pill-boxes or ordinary cardboard boxes, to breed the males and the parasites. After all these have emerged, the specimens should be put into envelopes with notes regarding dates of collection, locality, food-plant, damage done,

* Misra, C. S.—The American Blight of the Woolly Aphis, *Eriosoma lanigera*, Hausmann ; *Agri. Jour. India*, Vol. XV, Part VI, Nov. 1920, pp. 627—635.

amount of parasitization, and whether males were found or not. The envelope is then to be put into a large envelope with some powdered naphthaline inside to prevent growth of mould, etc.

A List of Coccidæ in the Pusa Collection.

(The arrangement is according to Fernald's Catalogue of Coccidæ of the World.)

MONOPHLEBINÆ—	
Monophlebus octocaudatus.	Mango shoots; Pusa. An unidentified creeper; Montgomery. Peach; Multan. Cotton shoots.
Monophlebus sp. (near *dalbergiæ*, Green)	Orange; Jaldhapi (Assam).
Monophlebus sp.	Orange; Pusa.
Walkeriana cinerea, Green.	*Achras sapota*; Pusa. Orange leaves; Cowerie-Betta (Sidapur, Coorg.) *Verbena.* *Dalbergia sissoo.*
Walkeriana (*Fissiventer*) *polei*, Green.	Guava; Mysore City. *Tabernemontana* sp.; Coorg.
Icerya seychellarum, Westw.	Orange; Myitkyina (Upper Burma).
Icerya minor, Green	Mango leaves; Pusa.
TACHARDIANÆ—	
Tachardia spp.	These are being re-examined in the light of material collected in the past. A full list will be given hereafter.
ASTEROLECANIINÆ—	
Cerococcus hibisci, Green	*Hibiscus liliflorus*; Bombay (Victoria gardens). Cotton; Pusa. Coffee; Calcutta. Erode. Sabour (Bihar).
Eriococcus araucariæ, Mask.	*Araucaria* sp.; Bangalore.
Anomalococcus cremastogastri, Green	*Acacia arabica*; Coimbatore.
DACTYLOPINÆ—	
Dactylopius (*Coccus*) *indicus*, Green	Calcutta.
Pseudococcus lilacinus, Ckll. (= *P. crotonis*, Green.)	*Achras sapota*; Sibpur (Calcutta). *Ailanthus excelsa*; Coimbatore.
Phenacoccus hirsutus, Green	*Acanthus ilicifolius*; Calcutta. Cotton; Pusa. Mulberry. *Ficus religiosa.*
Phenacoccus insolitus, Green	Cape gooseberry. Brinjal (leaves and fruits) Saidapet (Madras). *Sida rhombifolia*
Phenacoccus ballardi, Newst.	Mango fruits; Pusa.

DACTYLOPINÆ—*contd.*	
Phenacoccus iceryoides, Green	Mango; Coimbatore.
Phenacoccus mangiferæ, Green	Mango leaves; Coimbatore.
Ripersia sacchari, Green	Sugarcane: Poona. Rice seedlings; Chaumahani (Bengal). Hardia (Bihar).
Antonina indica, Green	Roots of grass; Bengal.
LECANIINÆ—	
Aclerda japonica, Newst.	Sugarcane; Jabalpur.
Eriochiton theæ, Green	Pears; Taliskar (Kashmir).
Takahashia japonica, Ckll.	Mulberry; Bhimtal. Jeolikote.
Ceroplastes actiniformis, Green.	*Ficus carica*; Pusa. Coconut fronds; Coimbatore.
Ceroplastes rubens, Mask.	Mango (leaves); Chicacole (S. India).
Ceroplastes floridensis Comst.	*Anona squamosa*; Pusa. *Ficus glomerata*.
Ceroplastes ceriferus, Anders.	*Casuarina*; Bombay.
Ceroplastodes cajani, Mask.	*Cajanus indicus*; Pusa. *Ocimum sanctum*; Coimbatore. *Zizyphus jujuba*. *Ficus glomerata*.
Pulvinaria psidii, Mask.	Mango; Coimbatore. Pusa. Guava; Poona. *Citrus* plant; Bangalore, Mysore City. *Eugenia jambolana*; Belgaum.
Pulvinaria polygonata, Ckll.	Mango (stems and leaves); Pusa.
Pulvinaria sp. (near *citricola*, Kuw.)	Mango shoots; Pusa.
Pulvinaria cellulosa, Green	Mango (leaves and stems); Pusa.
Lecanium nigrum, Nietner	*Justicia* sp.; Maymyo (Upper Burma). South Mysore *Morus indica*; Pusa. *Morus* sp.; Myitkyina (Upper Burma). Dharwar. Guava; Sidapur (Coorg).
Lecanium bicruciatum, Green.	Mango; Coimbatore.
Lecanium discrepans, Green.	*Zizyphus jujuba*; Pusa. Plaintain stem; Gauhati.
Lecanium capreæ, L.	Peach; Taliskar (Kashmir). Nectarines; Abbottabad (N.-W. F. P.) Loquat. Plum.
Lecanium ramakrishnæ, Green.	Pear; Kulu (Punjab).
Lecanium persicæ, Geoff.	*Morus indica*; Jhelum (Punjab).
Lecanium hesperidum, L.	*Citrus* sp.; Myitkyina (Upper Burma). Surat. Mango; Bangalore. Tuberose; Protapganj (Bengal).

LECANIINÆ—*contd.*

Lecanium oleæ, Bern.	Figs (green); Bangalore.
Lecanium longulum, Dougl.	Grape vines; Bangalore.
Lecanium hemisphæricum, Targ.	*Thunbergia* sp.; Tuttapallum (Nilgiris). Bombay. Pusa. Coffee; Nilgiris. Orange shoots; Virajpet (Coorg). *Hibiscus esculentus.* Coffee leaves; Coweriebetta estate (Sidapur, Coorg).
Lecanium imbricans, Sign.	*Cedrela toona*; North Mysore.
Hemilecanium imbricans, Green.	*Cedrela toona*; Koppa (North Mysore). Red cedar.

DIASPINÆ—

Chionaspis pusa, Green.	Orange (leaves and stems); Pusa.
Chionaspis dilatata, Green.	Mango leaves; Pusa. Raghunathganj (Bengal). Dacca.
Chionaspis vitis, Green.	Mango; Coimbatore.
Chionaspis centripetalis, Green.	Apple leaves; Srinagar (Kashmir). Olive.
Chionaspis (Phenacaspis) megaloba, Green	*Zizyphus jujuba* stems; Pusa.
Chionaspis hedyotidis, Green.	*Mallotus philippinensis*; Rilbe. near Kangra, 3,000 ft. (Punjab).
Chionaspis varicosa, Green.	Lashio (Burma).
Howardia biclavis, Comst.	Coffee stems; Wynaad (S. India).
Pinnaspis (Hemichionaspis) aspidistræ, Sign.	Ferns (imported); Bombay. Wynaad (Nilgiris).
Pinnaspis (Hemichionaspis) minor, Mask.	Croton; Pusa.
Pinnaspis buxi, Bouché.	*Dracæna* leaves; Bombay.
Diaspis echinocacti, Bouché.	*Opuntia* sp.; Coimbatore.
Diaspis (Aulacaspis) cinnamoni mangiferæ, Newst.	Mango leaves; Chicacole (S. India). Pusa.
Diaspis pentagona, T. T.	Cherry stems; Shillong (Assam).
Diaspis calyptroides, Costa.	*Opuntia* sp.; Bombay.
Fiorinia sp. nov. allied to *proboscidaria* and *fronticontracta*, Green.	*Aegle marmelos* (leaves); Pusa.
Aspidiotus destructor, Sign.	Orange; Kumbalenguna (Cochin state). *Cocos nucifera*; Laccadive islands. Plantain (leaves); Coimbatore. Mango leaves; Moovathi (South Wynaad). *Eugenia jambolana*; Pusa. Chaumahani (Bengal).

DIASPINÆ—*contd.*

Aspidiotus camelliæ, Sign.	Tea stems; Bangalore. (Nilgiris, South India).
Aspidiotus lataniæ, Sign.	*Zizyphus jujuba*; Bangalore. *Tamarindus indica* (Fruit pods) Coimbatore. *Ficus carica* fruits; Pusa. *Dalbergia sissoo.* *Psidium Guajava.* *Xylophylla elongata.* Plantain (leaves). An unidentified bush. Grape vines. Rose. *Pipal* (*Ficus religiosa*).
Aspidiotus orientalis, Newst.	*Cassia fistula*; Pusa. *Aegle marmelos*; Alleppey (Travancore). Coconut leaves; Dhamdha (C. P.). Plantain leaves; Bilaspur (C. P.). *Melia azadirachta*; Muzaffarpur. *Ficus religiosa*; Mandalay (Burma). *Anacardium occidentale*; Rajnagar (Darbhanga). Garden Palm. Rose stems. *Eugenia jambolana.* *Zizyphus jujuba.* *Schleichera trijuga.* *Tamarindus indica.* *Butea frondosa.*
Aspidiotus trilobitiformis, Green.	Mango leaves; Pusa.
Aspidiotus rossi, Mask.	Pomegranate leaves; Bilaspur (C. P.). Guava; Coimbatore. Mango.
Aspidiotus hartii Ckll.	Rhizomes of turmeric; Poona.
Aspidiotus ficus, Ashm.	Bamboo; Coimbatore. Mango; Poona. Palms; Calcutta.
Aspidiotus perniciosus, Comst	Pear; Kulu (Punjab).
Aspidiotus transparens, Green.	Grape vines; Pusa.
Aspidiotus dictyospermi, Morg.	Mango; Coimbatore.
Chrysomphalus (*Aspidiotus*) *aurantii*, Mask.	Orange leaves; Pusa. Pomelo; Myitkyina (Upper Burma). *Cycas cercinalis*; Attended by a parasitic fungus. *Cycas recurvata.* Rose stems; Bombay. Mulberry stems; Dhamdha (C. P.).
Chrysomphalus (*Aspidiotus*) *triglandulosus*, Green.	Jak; Bangalore. A forest tree; Mahableswar (Bombay).

DIASPINÆ—*concld.*	
Pseudaonidia trilobitiformis, Green.	*Ficus glomerata*; Pusa.
Lepidosaphes gloverii, Pack.	Mango leaves, Croton; Pusa.
Lepidosaphes gloverii var. *pallida*, Green.	Mango leaves; Allahabad.
Lepidosaphes beckii, Newm.	Pepper vines; Pollibetta (Coorg).
Lepidosaphes piperis, Green.	Madras.
Parlatoria pergandei var. *camelliæ*, Comst.	Grape-vine stems; Bangalore. Mango leaves; Alwar (Rajputana). *Aegle marmelos*; Pusa. Olive (imported from Spain); Taru (Peshawar).
Parlatoria blanchardii, Targ.	Date-palm; Lyallpur (Punjab).
Parlatoria calianthena, Berl. and Leon.	*Jasminum sambac*; Pusa. Mango leaves; Bilaspur. Alwar (Rajputana).
Parlatoria proteus, Curtis.	Orchid (*Rhyncostylis retusa*); Victoria Gardens, (Bombay). *Kentia pamoreane.*
Parlatoria proteus var. *mytilaspiformis*	*Cycas revoluta*; Victoria Gardens (Bombay).
Parlatoria proteus var. *crotonis*, Dougl.	Croton; Pusa.

A List of Foreign Coccidæ in the Pusa collection.

(These specimens were obtained in exchange for the local species of Coccidæ).

Lecaniodiaspis rufescens Ckll.—Foristiera neo-mexicana—Lone Pine—Owens Valley, California.

Eriococcus onikii, Kuwana.—Kern Co., California.

Ceroplastes sinensis, D. G.—Italy.

Coccus mangiferæ, Green.—Mango, Mayaguez, Porto Rico.

Saissetia oleæ, Bern.—Olive, California.

Chionaspis salicis nigræ, Walsh.—Willow, California.

Diaspis boisduvalii, Sign.—Palm, California.

Aulacaspis rosæ, Bouche.—Rose, California.

Aulacaspis pentagona, Targ.—Cherry, Japan. Bucarre, Mayaguez, Porto-Rico.

Aulacaspis manzanitæ W.—Manzanita, California.

Fiorinia fiorinia, Targ.—Palms-nursery, San Francisco, California.

Epidiaspis piricola, Del Guer.—Prune, California.

Aspidiotus cyanophylla, Sign.—Dillenia indica, Mayaguez, Porto Rico.

Aspidiotus æsculi, John.—Californian Buck eye. Los-Gotro, California.

Aspidiotus californiacus, Coleman,—Digger Pine, California.

Aspidiotus densiflora Bremenr.—Quercus agrifolia, California.

Aspidiotus hederæ, Voll.—Magnolia, California.

Aspidiotus rapax, Comst.—Laurel, Santa Barbara, California.

Chrysomphalus aurantii, Mask.—Orange, Los angeles, California.

Chrysomphalus aurantii var. *citrinus*, Coq.—Orange, California.

Chrysomphalus aonidum L.—Orange, Mayaguez, Porto Rico.

Chrysomphalus personatus, Comstk.—Coconut, Porto Rico.

Chrysomphalus rossii, Mask.—Araucaria bidwilli, Los Angeles, California.
Lepidosaphes ulmi, Linn.—Apple, California.
Ischnaspis longirostris, Sign.—Palm, Mayaguez, Porto Rico.

During my visit to America in 1921, I gathered that *Aspidiotus perniciosus* was so well under control that it was no longer regarded there as a serious pest. **Dr. K. Kannan.**

San José Scale is a serious pest in Kashmir and is very far from being under control. For example, an apple orchard of which the produce in 1921 was sold for Rs. 1,600 was then found to have a very slight infection of *A. perniciosus*. The very next year the attack became so intense that the value of the fruit was practically *nil* and the whole of the orchard had to be cut down and burnt. Trees in the damper and lower regions of the valley are more susceptible than those on the higher and drier areas. All sorts of fruit trees excepting Almonds were attacked by this pest. **Mr. Ram Gopal.**

52.—A CATALOGUE OF THE BRACONID WASPS DESCRIBED FROM THE INDIAN REGION.

By T. V. Ramakrishna Ayyar, B.A., F.E.S., *Assistant Entomologist, Madras.*

The following list, which was primarily prepared for the use of the writer, is published with the idea that it may help anyone taking up the systematic study of this interesting and economically important family of Indian insects. There is no doubt that many of the names in the list may be synonyms or the whole classification itself may require a thorough revision ; all the same, as a connected bibliographical record of the past literature on the family, this paper may serve some useful purpose. Prominent among the previous workers stands Cameron, whose chief contributions on Indian forms appeared in the pages of the *Memoirs of the Manchester Philosophical Society,* in the *Entomologist,* and in the *Journal of the Bombay Natural History Society.* Among others, mention may be made of Walker, Brullé, Ashmead, Szepligeti, Viereck, Enderlein, and Silvestri. The arrangement followed below is that of Szepligeti in his *Genera Insectorum* volume on the family. The geographical area considered in this list includes India, Burma and Ceylon.

Aphrastobraconinae.

Aphrastobracon, Ashmead.

A. flavipennis, Ashm., Proc. U. S. Nat. Mus., XXIII, p. 646. (1900). Pundaluoya.

Braconinæ.

Vipio, Latreille (*Glyptomorpha,* Holm).

V. bicarinatus, Brullé, Hist. Nat. Ins. Hym., IV, p. 438 (1846). India.

V. scutum, Brullé, Hist. Nat. Ins. Hym., IV, p. 437 (1846) Do.

V. nursei, Cameron, B. J., XVII, p. 106 (1906) . . Quetta.

V. unicolor, Cameron, B. J., XVII, p. 107 (1906) . . Do.

Chaoilta, Cameron.

C. lamellata, Cameron, Manch. Mem., XLIII(3), p. 80, 1899) Khasi Hills.

BRACONINÆ—*contd.*

Iphiaulax, Förster.

I. elizeus, Cameron, Entomologist, p. 107 (1905)	Deesa.
I. smeenus, Cameron, Entomologist, p. 107 (1905)	Do.
I. xanthopsis, Cameron, Spol. Zeyl., III, p. 82 (1905)	Elephant Pass (Ceylon).
I. fulvopilosus, Cameron, Spol. Zeyl., III, p. 83, (1905)	Kandy (Ceylon).
I. greeni, Cameron, Spol. Zeyl., III, p. 83 (1905)	Peradeniya.
I. ernesti, Cameron, Spol. Zeyl., III, p. 84 (1905)	Do.
I. kirbyi, Cameron, Spol. Zeyl., III, p. 85 (1905)	Kandy.
I. erythroura, Cameron, Spol. pl. A. fig. 7, p. 85 (1905)	Do.
I. haragamensis, Cameron, Spol. pl. A. fig. 7, p. 86 (1905).	Haragam (Ceylon).
I. spilocephalus, Cameron, B. J., XVIII, p. 584 (1907)	Deesa.
I. domdamiensis, Cameron, A. M. N. H., XIX, p. 170, (1907.)	Tenasserim.
I. haundrawensis, Cameron, A. M. N. H., XIX, p. 171 (1907).	Do.
I. stramineus, Cameron, A. M. N. H., XIX, p. 172 (1907)	Do.
I. burmaensis, Cameron, A. M. N. H., XIX, p. 172 (1907).	Lower Burma.
I. lineaticarinatus, Cameron, A. M. N. H., XIX, p. 173 (1907).	Sikkim.
I. sikkimensis, Cameron, A. M. N. H., XIX, p. 174 (1907)	Do.
I. hookeri, Cameron, A. M. N. H., XIX, p. 174 (1907)	Do.
I. campbelli, Cameron, A. M. N. H., XIX, p. 175 (1907)	Do.
I. tenasserimensis, Cameron, A. M. N. H., XIX, p. 176 (1907).	Tenasserim.
I. sal, Cameron, Ind. For. Rec., IV, p. 107 (1913)	Himalaya.
I. immsi, Cameron, Ind. For. Rec., IV, p. 107 (1913)	Do.

Philomacroplœa, Cameron.

P. basimacula, Cameron, Spol Zeyl., III, pp. 87-88 (1905)	Ceylon.

Rhacospathius, Cameron.

P. striolatus, Cameron, Spol. Zeyl., III, pp. 86-87 (1905)	Kandy.

Delmira, Cameron.

D. triplagiata, Cameron, Manch. Mem., XLIV, p. 88 (1900)	Khasi Hills.

Pycnobracon, Cameron.

P. niger, Cameron, B. J., XIV, tab., fig. 13, p. 436 (1902)	Simla.

Rhadinobracon, Szepligeti.

R. luteus, Szepligeti, Ann. Mus. Nat. Hist. Hungary, IV, p. 556 (1906).	Ceylon.

BRACONINÆ—*contd.*

Microbracon, Ashmead.

M. lefroyi, Dudgeon and Gough, Agri. Journ. Egypt, III, p. 109 (1914).	Punjab.

Bracon, Fabricius.

B. aculator, Fabricius, Ent. Syst., II, p. 159 (1793) .	Tranquebar.
B. femorator, Fabricius, Ent. Syst., II, p. 159 (1793) .	Do.
B. laminator, Fabricius, Supp. Ent. Syst., p. 220 (1798) .	India.
B. richei, Brullé, Hist. Nat. Insect. Hym., IV, p. 424 (1846).	Do.
B. apicalis, Brullé, Hist. Nat. Insect. Hym., p. 432, *B. indicus*, Dalla Torre, (1898).	Do.
B. jaculatus, Smith, Jour. Linn. Soc. London, IV, Suppl., p. 141 (1860).	Do.
B. sculptilis, Westwood, T. E. S., 1872, p. 127, t. XIV, fig. 27.	Ceylon.
B. greenii, Ashmead, Proc. U. S. Nat. Mus., XVIII, p. 645 (1895).	Pundaluoya.
B. ceylonicus, Cameron, Manch. Mem., XLI(4), p. 32 (1897), t. 3, fig. 5.	Ceylon.
B. tricarinatus, Cameron, Manch. Mem., XLI(4), p 33 (1897), t. 3, fig. 5.	Do.
B. itea, Cameron, Manch. Mem., XLI(4), p. 34 (1897), t. 3, fig. 5.	Trincomali
B. agraensis, Cameron, Manch. Mem., XLI (4), p. 34 (1897), t. 3, fig. 6.	Agra.
B. ingratus, Cameron, Manch. Mem., XLI (4), p. 35 (1897), fig. 6.	Do.
B. rothneyi, Cameron, Manch. Mem., XLI (4), p. 36 (1897), t. 3, fig. 6.	Do.
B. yerburyi, Cameron, Manch. Mem., XLI(4), p. 36 (1897), t. 3, fig. 6.	Trincomali.
B. leptogaster, Cameron, Manch. Mem., XLIII (3), p. 60 (1899).	Khasi Hills.
B. v-macula, Cameron, Manch. Mem., XLIII(3), p. 62 (1899).	Do.
B. orientalis, Cameron, Manch. Mem., XLIII(3), p. 63 (1899).	Do.
B. simlaensis, Cameron, Manch. Mem., XLIII(3), p. 65 (1899).	Simla.
B. lepcha, Cameron, Manch. Mem., XLIII(3), p. 66 (1899)	Khasi Hills.
B. phædo, Cameron, Manch. Mem., XLIII(3), p. 68 (1899)	Do.
B. himalayensis, Cameron, Manch. Mem., XLIII(3), p. 70 (1899).	Do.
B. indiscretus, Cameron, Manch. Mem., XLIII(3), p. 71 (1899).	Do.
B. khasianus, Cameron, Manch. Mem., XLIII(3), p. 72 (1899).	Do
B. umbratilus, Cameron, Manch. Mem., XLIII(3), p. 74 (1899).	Do.

BRACONINÆ—*concld.*

Bracon, Fabricius—*contd.*

B. dodonæus, Cameron, Manch. Mem., XLIII(3), p. 75 (1899).	Khasi Hills.
B. seditiosus, Cameron, Manch. Mem., XLIII(3), p. 76 (1899).	Do.
B. jejunus, Cameron, Manch. Mem., XLIII(3), p. 78 (1899)	Do.
B. declaratus, Cameron, Manch. Mem., XLIII(3), p. 79 (1899).	Do.
B. pauperatus, Cameron, Manch. Mem., XLIV (15), p. 83 (1900).	Do.
B. firmus, Cameron, Manch. Mem., XLIV, (15), p. 84 (1900)	Do.
B. nicevillei, Bingham, A. M. N. H., VIII, p. 555 (1901) .	Bengal.
B. famulus, Bingham, A. M. N. H., VIII, p. 556 (1901) . .	Do.
B. punjabensis, Cameron, B. J., XIV, p. 432 (1902) .	Punjab.
B. deesæ, Cameron, B. J., XIV, p. 433 (1902) . . .	Deesa.
B. asiaticus, Szepligeti, Ann. Hist. Nat. Mus. Hungary, p. 589 (1906).	Ceylon.
B. quettaensis, Cameron, B. J., XVII, p. 105 (1906) . .	Quetta.
B. iridipennis, Cameron, B. J., XVII, p. 106 (1906) .	Do.
B. thwaitesi, Cameron, Int. Ent. Zts., p. 281 (1910) . .	Ceylon.
B. pallidenotatus, Cameron, Int. Ent. Zts., p. 281 (1910)	Do.
B. tachardiæ, Cameron, Ind. For. Rec., IV, p. 106 (1913) .	Himalaya.
B. fletcheri, Silvestri, Boll. Labor. Portici., XI, pp. 160-162 (1916).	Pusa, Bihar.

EXOTHECINÆ.

Spinaria, Brullé.

S. spinator, Guerin, Voy. Coquill, Zool., II, p. 199 (1830)	India.
S. leucomelæna, Westwood, T. E. S., 1882, p. 31, t. VII, fig. 2. ; Fletcher, Second Hundred Notes on Indian Insects. Pusa, p. 9.	India, Coorg.
S. nigriceps, Cameron, Manch. Mem., XLI (4), p. 37 (1897) :	Madras, Ceylon.
Ramakrishna Ayyar, Rept. of 4th Entomol. Meeting, Pusa.	Madras.
S. albiventris, Cameron, Manch. Mem., XLIII (3), p. 82 (1899).	Khasis.
S. trimaculata, Cameron, Manch. Mem., XLIV (15), p. 81 (1900).	Do.
S. flavipennis, Cameron, Entomologist, 1906, p. 205 .	Sikkim.
S. bhotanensis, Cameron, Entomologist, 1906, p. 206 .	Buxa (Bhutan).

Exothecus, Wesmael.

E. nigropectus, Cameron, Tijd. Ent., LIII, p. 41 (1910) .	Darjiling.
E. maculipennis, Cameron, Tijd. Ent., LIII, p. 42 (1910) .	Ceylon.

Phanaulax, Cameron.

P. levituberculatus, Cameron, Tijd. Ent., LIII, p. 43 (1910)	Ceylon.

SPATHIINÆ.

Spathius, Nees.

S. bisignatus, Walker, A. M. N. H., V., p. 309 (1860) .	Ceylon.
S. signipennis, Walker, A. M. N. H., V., p. 309 (1860) .	Do.
S. rufotestaceus, Motschulsky, Bull. Soc. Nat. Moscow, XXXVI, p. 31 (1863).	Do.
S. trichiosomus, Cameron, Tijd. Ent., LIII, p. 45 (1910) .	Do.

Rhoptrospathius, Cameron.

R. striatus, Cameron, Tijd. Ent., LIII, p. 47 (1910) . .	Ceylon.

DORYCTINÆ.

Trichiobracon.

T. striolatus, Szepligeti ; Turner, A. M. N. H., X, p. 275 (1922).	Dehra Dun.

Holcobracon, Cameron.

H. fulvus, Cameron, Spol. Zeyl., III, p. 90, (1905), t. A., fig. 6	Kandy : also at Dehra, see A. M. N. H. (9) X 1922, p. 275.
H. coxalis, Turner, A. M. N. H. (9), X, p. 274 (1922) .	Dehra Dun.
H. fulvus, Cam., Sub species *atriceps*, Turner, A. M. N. H. (9), X, p. 275 (1922).	Do.

Odontobracon, Cameron.

O. flavipennis, Brullé, Hist. Nat. Ins. Hym., IV, p. 463 (1846).	India.

Ontsira, Cameron.

O. reticulata, Cameron, Manch. Mem., XLIV, (15), p. 90 (1900).	Khasis.

Dorycles, Haliday.

D. solox, Enderlein, Arch. Für. Naturges, 78, A. H. S., II, p. 27 (1912).	Ceylon.

HORMIINÆ.

Spathiohormius, Enderlein.

S. filicornis, Enderlein, Arch. Fur. Naturges. 78, A. H. F., p. 21 (1912).	Peradeniya.

HORMIINÆ—*contd.*

Pegarthrum, Cameron.

P. rufescens, Cameron, Tijd. Ent., LIII, p. 49 (1910) .	Ceylon.

RHOGADINÆ.

Gyroneuron, Kokiyew.

G. mirum, Kok, Rv. Russ. Ent., I, p. 232 (1901) . .	Assam.

Rhogas, Nees.

R. coloratus, Motschulsky, Bull. Soc. Nat. Moscow, XXXVI, p. 33 (1863).	Ceylon.
R. (?) *mandibularis*, Cameron, Manch. Mem., XLIV, (15), p. 85 (1900).	Khasis.
R. grandimaculatus, Cameron, Wien. Ent. Zeit., XXIX, p. 2 (1910).	Ceylon.
R. indicus, Cameron, Wien. Ent. Zeit., XXIX, p. 2 (1910)	N. India (Sitka).
R. pilosus, Cameron, Wien. Ent. Zeit., XXIX, p. 3 (1910)	Ceylon.
R. crassipalpus, Enderlein, Arch. Fur. Naturges, 78, A. Hf., VI, p. 94 (1912).	Do.
R. ceylonicus, Enderlein, Arch. Fur. Naturges, 78, A. Hf., VI, p. 94 (1912).	Do.
R. breviventris, Enderlein, Arch. Fur. Naturges, 78, A. Hf., VI, p. 95 (1912).	Nuwara Eliya (Ceylon).
R. tricolor, Enderlein, Arch. Fur Naturges, 78, A. Hf., VI, p. 95 (1912).	Nalanda (Ceylon).

Heterogamus, Wesmael.

H. percurrens, Lyle, Bull. Ent. Res., XII, 130-132 . .	Bihar (par on *Achaea janata*)

Paraspinaria, Cameron (*Conspinaria*, Schulz 1906).

P. pilosa, Cameron, Spol. Zeyl., III, p. 88 (1905) . .	Kandy.

Tropobracon, Cameron.

T. luteus, Cameron, Spol. Zeyl., III, p. 91 (1905) . .	Pundaluoya.

Tropor hogas, Cameron.

T. spilonotus, Cameron, Spol. Zeyl. III, p. 93 (1905) .	Peradeniya.
T. albipes, Cameron, Spol. Zeyl., III, p. 93 (1905) . .	Kandy
T. maculipennis, Cameron, Spol. Zeyl., III, p. 94, t. A, fig 5	Do.
T. tricolor, Cameron, Spol. Zeyl., III, pp. 94-95, t. A fig 8	Do.
T. ruficeps, Cameron, Spol. Zeyl., III, p. 95, t. A., fig. 8	Peradeniya.
T. lateralis, Cameron, Spol. Zeyl., III, pp. 95-96, t. A., fig. 8	Do.
T. trimaculatus, Cameron, Spol. Zeyl., III, p. 96, t. A., fig. 8	Kandy.

CHELONINÆ.

Chelonus, Jurine.

C. albofasciatus, Motschulsky, Bull. Soc. Nat. Moscow, XXXVI, p. 38 (1863).	Ceylon.
C. tricoloratus, Cameron, Spol. Zeyl., III, p. 79 (1905) .	Trincomali.
C. areolatus, Cameron, B. J., XVII, p. 103 (1906) . .	Quetta.
C. fortispinus, Cameron, B. J., XVII, p. 103 (1906) .	Do.
C. indicus, Cameron, B. J., XVII, p. 584 (1907) . .	Ferozepore.
C. salebrosus, Enderlein, Arch. Naturges, 78, A. H. F., VI, p. 97 (1912).	Ceylon.

Phanerotoma, Wesmael.

P. hendecasisella, Cameron, Spol. Zeyl., III, p. 80 (1905) .	Peradeniya.

MICROGASTERINÆ.

Apanteles, Förster.

A. (Cotesia) flavipes, Cameron, Manch. Mem., IV, p. 185 (1891); Cotes, Ind. Mus. Notes, II, p. 155 (1892) [parasitic on *sorghum* borer.]	N. India.
A. pratapæ, Ashmead, Proc. U. S. Nat. Mus., XVIII, p. 647 (1895).	Ceylon.
A. tiracholæ, Ashmead, Proc. U. S. Nat. Mus., XVIII, p. 647 (1895).	Pundaluoya.
A. taprobanæ, Cameron, Manch. Mem., XLI, (4), p. 38 (1897).	Trincomali.
A. (Protapanteles ?) nigrescens, Cameron, B. J., XVII, p. 102 (1906).	Quetta.
A. acherontiæ, Cameron, Spol. Zeyl., V, pp. 17-18 (1907); Green, *t. c.*, p. 19, tab.	Peradeniya.
A. (Pseudapanteles) leptothecus, Cameron, B. J., XVII, p. 585 (1907).	Deesa.
A. paludicolæ, Cameron, Spol. Zeyl., VI, p. 41 (1909) .	Diyatalawa.
A. platyptiliæ, Cameron, Spol. Zeyl., VI, pp. 41-42 (1909)	Madulsima.
A. stegenodactylæ, Cameron, Spol. Zeyl., VI, p. 42 (1909) .	Galle.
A. bisulcata, Cameron, Spol. Zeyl., VI, pp. 42-43 (1909) .	Weligama.
A. leptoura, Cameron, Spol. Zeyl., VI, p. 43 (1909) . .	Madulsima.
A. prodeniæ, Viereck, Proc. U. S. Nat. Mus., XLII, p. 139 (1912) [par. on *Prodenia litura*].	Bangalore.
A. taragamæ, Viereck, Proc. U. S. Nat. Mus., XLII, p. 140, (1912) [par. on *Taragama dorsalis*].	Do.
A. (Protapanteles) colemani, Viereck, Proc. U. S. Nat. Mus., XLII, p. 143 (1912) [par. on *Orgyia postica*].	Vegati (Mysore).
A. (P.) creatonoti, Viereck, Proc. U. S. Nat. Mus., XLII, p. 144 (1912) [par. on *Creatonotus albistriga*].	Homalli (Mysore).
A. (P.) papilionis, Viereck, Proc. U. S. Nat. Mus., XLII, p. 145 (1912) [par. on *Papilio demoleus*].	Mysore.

MICROGASTERINÆ—*contd.*

Apanteles, Förster—*contd.*

A. (*P.*) *stauropi*, Viereck, Proc. U. S. Nat. Mus., XLII, p. 146 (1912) [par. on *Stauropus alternus*].	Bangalore.
A. tachardiæ, Cameron, Ind. For. Rec., IV, p. 109 (1913) .	Himalaya.
A. phycodis, Viereck, Proc. U. S. Nat. Mus., XLIV, p. 557 (1913) [par. on *Phycodes radiata*].	Bangalore.
A. plusiæ, Viereck, Proc. U. S. Nat. Mus., XLIV, p. 557 (1913) [par. on *Plusia agramma*].	Do.

Ectadiophatnus, Cameron.

E. tachardiæ, Cameron, Ind. For. Records, IV, p. 108 (1913)	Himalaya.

Microgaster, Latreille.

M. detracta, Walker, A. M. N. H., V, p. 308 (1860) . .	Ceylon.
M. recusans, Walker, A. M. N. H., V, p. 308 (1860) . .	Do.
M. significans, Walker, A. M. N. H., V, p. 308 (1860) .	Do.
M. subducta, Walker, A. M. N. H., V, p. 309 (1860) .	Do.
M. annulipes, Mots, Bull. Soc. Nat. Moscow, XXXVI, p. 34 (1863).	Do.
M. nigricornis, Mots, Bull. Soc. Nat. Moscow, XXXVI, p. 35 (1863).	Do.
M.? carinicollis, Cameron, Spol. Zeyl., III, p. 81 (1905) .	Do.
M. himalayensis, Cameron, Wien. Ent. Ztg., XXIX, p. 5 (1910).	Darjiling.

Microplitis, Förster.

M. similis, Lyle, Bull. Ent. Res., p. 129 (1921) . .	Pusa, Mokameh, Sabour (Bihar).
M. eusirus, Lyle, Bull. Ent. Res., pp. 129-30 (1921) . .	Pusa.
[*M. ophiusæ*, Ramakrishna Ayyar, Bombay Natural History Journal, par. on Noctuid *Achœa janata*].	S. India.

AGATHINÆ.

Disophrys, Förster.

D. ruficollis, Cameron, Manch. Mem., XLIII (3), p. 98 (1899).	Khasis.
D. erythrocephala, Cameron, Manch. Mem., XLIV (15), p. 91 (1900).	Do.
D. (?) *ephippium*, Cameron, Manch. Mem., XLIV (15), p. 93 (1900).	Do.
D. dehraensis, Turner, A. M. N. H., (9), X, p. 277 (1922) .	Dehra Dun.

Agathis, Latreille.

A. maculipennis, Brullé, Hist. Nat. Ind. Hym., IV, p. 488 (1846).	India.
A. semifusca, Brullé, Hist. Nat. Ind. Hym., IV, p. 440 (1846).	Do.

AGATHINÆ—*contd.*

Agathis, Latreille—*contd.*

A. subfasciata, Brullé, Hist. Nat. Ind. Hym., IV, p. 489 (1846).	India.
A. khasiana, Cameron, Manch. Mem., XLIII (3), p. 84 (1899).	Khasis.
A. forticarinata, Cameron, Manch. Mem., XLIII (3), p. 86 (1899).	Do.
A. nigritarsis, Cameron, Manch. Mem., XLIII (3), p. 87 (1899) [*A. infortunata*, Scholz (1906)].	Do.
A. nigritarsis, Cameron, Manch. Mem., XLIII (3), p. 92 (1899).	Do.
A. perornata, Cameron, Manch. Mem., XLIII (3) p. 89 (1899)	Do.
A. melanocerus, Cameron, Manch. Mem., XLIII (3), p. 91 (1899).	Do.
A. fuliginosa, Cameron, Manch. Mem., XLIII (3), p. 93 (1899).	Do.
A. rufoplagiata, Cameron, Zeit. Hym., Dipt., IV, p. 5 (1904)	Sikkim.
A. kandyensis, Cameron, Spol. Zeyl., III, p. 77 (1905) .	Kandy.
A. oya, Cameron, Spol. Zeyl., III, p. 78 (1905) . .	Do.
A. ceylonicus, Cameron, Spol. Zeyl., III, p. 78 (1905) . .	Do.
A. abuensis, Cameron, Zs. Hym. Dipt., p. 465 (1907) .	India.
A. lepcha, Cameron, Tijd. Ent., p. 113 (1907) . . .	Sikkim.

Orgilus, Haliday.

O. nigromaculatus, Cameron, B. J., XVII, p. 105 (1906) .	Quetta.

Enagathis, Szepligeti.

E. cryptophlebiæ, Viereck, Proc. U. S. Nat., XLIV, p. 559 (1913) [par. on *Argyroploce illepida*].	Davanahalli (Mysore).

Lisitheria, Cameron.

L. nigricornis, Cameron, Entomologist, p. 306 (1904) .	Deesa.

Braunsia, Kriechbaumer.

B. terminalis, Brullé, Hist. Nat. Ins. Hym., IV, p. 484 (1846).	India.
B. flavofasciata, Mots. Bull. Soc. Nat. Moscow, p. 33 (1863)	Ceylon.
B. cariosa, Enderlein, Zool. Jahrb. Syst., XX, p. 450 (1904)	Do.

Cremnops (*Bracon*), Förster.

C. (*Bracon*) *desertor*, L. Turner, A. M. N. H. (9), X, p. 278 (1922).	Dehra Dun.

Microdus, Nees.

M. tuberculatus, Cameron, Manch. Mem. XLIII (3), p. 95 (1899).	Khasis.
M. fumipennis, Cameron, Manch. Mem', XLIII, (3), p. 96 (1899).	Do.
M. greeni, Cameron, Spol. Zeyl., III, p. 79 (1905) . .	Kandy.

BLACINÆ.

Psyttalia, Walker.

P. testacea, Walker, A. M. N. H., p. 311 (1860)	Ceylon.

CARDIOCHILINÆ.

Cardiochiles, Nees. (*Dithereus*, Cameron 1902).

C. (*D.*) *ruficollis*, Cameron, B. J., XIV, p. 435 (1902)	Simla.
C. nigricollis, Cameron, B. J., XVII, p. 102 (1906)	Quetta.
C. erythronotus, Cameron, B. J., XVII, p. 102 (1906)	Do.
C. ceylonicus, Enderlein, Stett. Ent. Ztg., LXVII, p. 251 (1906).	Ceylon.
C. fulvus, Cameron, Zs. Hym. Dipt., 1907, p. 466	India.

MACROCENTRINÆ.

Macrocentrus, Curtis.

M. ceylonicus, Enderlein, Arch. Naturg. 78. A. Hf., II, p. 99 (1912).	Ceylon.

Zele, Curtis.

Z. assamensis, Cameron, Tijd. Ent., LIII, p. 54 (1910)	Assam.

Xiphozele, Cameron.

X. compressiventris, Cameron, Entomologist, p. 208 (1906)	Sikkim.

OPIINÆ.

Biosteres, Förster.

B. carpomyiæ, Silvestri, Boll. Labor. Portici., XI, pp. 165-167 (1916).	Pusa.
B. persulcatus, Silvestri, Boll. Labor. Portici., XI, pp. 167-168 (1916).	Coorg; Lashio (3,000 ft.).
B. compensans, Silvestri, Boll. Labor. Portici., XI, pp. 168-169 (1916).	Coorg.

Diachasmimorpha, Viereck.

D. comperei, Viereck, Proc. U. S. Nat. Mus., XLIV, p. 641 (1913) [par. on fruit fly].	S. India.

Opius, Wesmael.

O. ducusii, Cameron, Spol. Zeyl., III, p. 210 (1906) [par. on fruit fly on cucurbits].	Peradeniya.
O. fletcheri, Silvestri, Boll. Labor. Portici., XI, pp. 163-164 (1916).	India.
O. incisi, Silvestri, Boll. Labor. Portici., XI, pp. 164-165 (1916).	Pollibetta, S. Coorg.

METEORINÆ.

Meteorus, Haliday.

M. arctiicida, Viereck, Proc. U. S. Nat. Mus., XLII, p. 141 (1912) [par. on Arctiad larva]. Mysore.

APHIDIINÆ.

Aphidius, Nees.

A. colemani, Viereck, Proc. U. S. Nat. Mus., XLII, p. 141 (1912) [par. on tobacco Aphis]. Bangalore.

DACNUSINÆ.

Heratemis, Walker.

H. filosa, Walker, A. M. N. H., V, p. 310 (1860) . . Ceylon.

Nebartha, Walker.

N. macropodides, Walker, A. M. N. H., V, p. 310 (1860) . Do.

ALYSIINÆ.

Aspilota, Förster.

A. ceylonica, Ashmead, Ent. News, XV. p. 113 (1904) . Peradeniya.

Holocalysia, Cameron.

H. ruficeps, Cameron, Wien. Ent. Ztg., XXIX, p. 6 (1910) Tenasserim.

Aclisis, Förster.

A. (?) *cilipennis*, Cameron, Wien. Ent. Ztg., XXIX, p. 10 (1910). Darjiling.

Rhacalysia, Cameron.

R. rufobalteata, Cameron, Wien. Ent. Ztg., XXIX, p. 10 (1910). Do.

Asobara, Förster.

A. orientalis, Viereck, Proc. U. S. Nat. Mus., XLIV, p. 639, (1913) [par. on fruit fly]. S. India.

53.—A NOTE ON COLOUR VARIATIONS IN A COMMON LADY-BIRD BEETLE, *CHILOMENES SEXMACULATA*, FB.

By T. V. SUBRAMANYAM, B.A., *Assistant to Government Entomologist, Madras.*

In the year 1921-22 most of the Cambodia cotton-fields in the Central Farm, Coimbatore, suffered rather badly from an attack of *Aphis gossypii* during the months of November-December 1921 and March-April 1922. Aphis was also rather bad on the *cholam* plants during May-June 1922. In both these cases the pest was kept in check to a very great extent by lady-bird beetles. There were different kinds of these at work, voraciously feeding on the Aphids both in the larval and in the adult stages.

One of these was coloured completely yellow with a single black longitudinal line along the median suture of the elytra. Some of these had an orange tinge. Another species had, in addition to the above colour, on each elytron, a short black wavy line across it in front, a longer one in the middle and a black dot towards the hind end. There was yet another series where the beetles were absolutely black in colour. On a reference to our collection it was found that the three were put down as belonging to three different genera. The first series was named *Chilomenes sexmaculata*, the second *Verania discolor* and the third *Chilocorus nigritus*.

During the above seasons in the year 1921-22 it was observed that individuals of all these three series mated freely with one another in the field. This roused my curiosity and gave room for the suspicion that after all these three different series may be only variations of the same species. With this idea in mind a few pairs in copulation with different individuals were collected and efforts made to rear out the offspring. Though the rearings were not repeated the results tended to show that after all the above doubt was founded on facts. The larvæ in all cases were similar in appearance and habits, while the adults were different. In few cases forms intermediate between the father and the mother were obtained. For instance, out of a couple where one of the parents was of the first series and its partner of the second series, the offspring were in a few cases of the first series and in certain others of the second series, while in a few instances a combination of the characters of both was noted. This led to a search for the intermediate forms in the field and in this I was not disappointed. It was possible

to collect a series of insects showing a gradual transition in colour markings from the second series, through the first to the third.

This led to the conclusion that, as was suspected at first, all these were only different variations of colour exhibited by different individuals of the same species. This was confirmed by the Imperial Bureau of Entomology when all these were returned identified as one and the same species, *Chilomenes sexmaculata*, with a note that the forms under this species exhibit a great variation in colour.

The exact reason for this assumption of different colours by individuals of the same species is not quite clear. So far as could be observed there seems to be no sexual significance because both the sexes are to be met with in all the colours. Future observations may bring to light some purpose for these variations.

There is a very wide range of colour variation in Coccinellid beetles and perhaps a number of hitherto described species in which colour pattern is a basis for differentiation may ultimately be reduced to a few definite species.

54.—THE ODONATE FAUNA OF THE PALNI AND NILGIRI HILLS.

By Major F. C. FRASER, I.M.S.

I am afraid that the title of this paper is somewhat misleading for, as will be seen from a casual glance at the lists below, only a small part of the dragonfly fauna of the two districts comes into discussion. My intention was not so much to give an account of the Odonate fauna of the two hill-stations as to employ a comparison of the dragonfly fauna as a general illustration of the way in which species are spread from hill-top to hill-top.

Dragonflies were collected by myself in the Palnis in 1908 and more recently by Mr. Bainbrigge Fletcher in the year 1921.

Both collections were made at an altitude of over 5,000 feet so that they cannot be said to be truly representative of the whole of the Palnis. On the other hand, I have been able to make an almost complete survey of the Odonate fauna from the Nilgiris, from altitudes of 1,000 to over 8,000 feet during the past two years. In order, therefore, to make a fair comparison of the fauna of the two districts, one has to restrict the list from the Nilgiris to those taken at over 5,000 feet. The comparison of such a restricted list, however, admirably serves the purpose of this paper.

In the following list the term *montane species* is taken to mean those species which are never found below the altitude of 5,000 feet, whilst *submontane species* means Plains species which have found their way up to an altitude of over 5,000 feet. Such definitions are of course only applicable here but are convenient ones, as we are ignorant of the species found below 5,000 feet in the Palnis.

A comparative list of montane and submontane species of dragonflies (Odonata) taken above the altitude of over 5,000 feet in the Palni and Nilgiri Hills.

Montane species.

Palni Hills.	*Nilgiri Hills.*
Orthetrum triangulare	All present.
Sympetrum fonscolombei	All present.
Hemicordulia asiatica	All present.
Anaciæschna donaldi	All present.
Anax immaculifrons	All present.
Pseudagrion bengalense	All present.
Esme cyaneo-vittata, represented by and nearly related to.	*Indoneura gomphoides* and *Indoneura ramburi*.
Lestes gracilis birmanus	Absent.

Submontane species.

Orthetrum chrysostigma luzonicum	
Orthetrum sabina	
Orthetrum glaucum	
Orthetrum pruinosum	
Diplacodes trivialis	All present.
Trithemis festiva	
Trithemis pallidinervis	
Pantala flavescens	
Palpopleura sexmaculata	
Acisoma panorpoides	
Crocothemis servilia	
Indothemis coesia	All absent.
Brachythemis contaminata	
Trithemis aurora	
Tramea limbata	
Anax guttatus	
All absent	*Ischnura senegalensis, Aciagrion occidentalis.* *Tramea basilaris.* *Gynacantha millardi.*

Single specimens of *Gynacantha hyalina*. *Anaciæschna jaspidea*. and *Ceriagrion rubiæ* have been taken in the Nilgiris at an altitude of 7,000 feet but are not included in the above lists as their occurrence is regarded as purely sporadic.

Of the montane species all except two have succeeded in crossing the sea of heated atmosphere dividing the two districts and establishing themselves in their new surroundings. Of the other two *Esme* and *Indoneura* are probably offshoots from a common branch, the latter possibly being *Phylloneura* which is found in the Nilgiris only. If this is so, then the separation must have been comparatively recent, as *Indoneura* has outpaced *Esme* only very slightly in the reduction of venation.

With regard to the last, *Lestes gracilis birmanus*, it is clear that it has spread northward from the montane areas of Ceylon, being intimately related to *Lestes gracilis gracilis* from that district. Its northerly emigration appears to have been arrested at the Palni Hills, as there are no other records of its distribution in India.

A glance at the list of submontane species will at once show that a greater number of these have ascended the heights of the Palni Hills than of the Nilgiris. The reason for this * is that the Nilgiris lie further North and so the temperatures of the upper plateau are decidedly lower than at the same height in the Palnis. As a proof of this we should expect to find the missing species at lower altitudes in the Nilgiris and

* A more obvious reason seems to be that the Palnis rise much more steeply from the surrounding Plains than do the Nilgiris.—*Editor.*

such proves to be the case, as, without exception, the eight species are quite common at an altitude of under 4,000 feet.

Gynacantha millardi will almost certainly be found in the Palni Hills and possibly also *Aciagrion occidentalis* and *Tramea basilaris*. Concerning the last species, *Ischnura senegalensis*, we find here the curious anomaly of a true Plains species having established itself in a montane area. Large stretches of water in montane areas are liable to trap species in flight across the hills and this has apparently happened in the present case. As a proof of this I find that the species swarms on the Ootacamund Lake but is a rarity on the Lovedale Lake, although the distance between the two stretches of water is less than two miles. A lofty ridge, however, separates the two lakes and proves an effectual barrier to the spread of the species. Both lakes are artificial and of comparatively modern formation, so that *I. senegalensis* is a modern immigrant to the Nilgiris. I have failed to find it in any of the marshes on the *kundahs* and Mr. Bainbrigge Fletcher did not find it present on the Kodaikanal lake. The occurrence of a few specimens on the Lovedale lake may mean that it has become established even more recently on that body of water.

It is a striking fact that, as we trace the distribution of certain montane insects northwards, they are found to occur at lower and lower elevations until at length what is purely a Hill species in the South, becomes an established Plains species in the far North. One may instance *Vanessa cardui*, which is found on the summits of all hills in Ceylon and Southern India, whilst in the Plains of the Northern Punjab and Sind it is quite common. *Vanessa indica*, another Hill species in the South, is not uncommonly taken in the Plains of the North. *Pseudagrion bengalense*, a small species of dragonfly found in the Plains of Bengal, becomes a Hill species in the Palni and Nilgiri Hills (over 5,000 feet in the Palnis and from 3,500 to 7,250 feet in the Nilgiris). Many other instances can be given.

Conversely a Plains species in the North is found at higher and higher elevations as we trace its distribution southwards. The list of submontane species of dragonflies given above may be taken as instances of this. The list for the Nilgiris at an altitude of over 5,000 feet is 12, whilst in the Palnis, further south, it rises to 16.

The origin of submontane species found at high elevations in the Southern Hills therefore offers an easy solution. They have spread in a continuous chain through the Plains, encircling and ascending the hills as the wave of emigration proceeded.

The problem of the origin of montane species is a much more difficult one. There are broad gaps between the mountain systems and wide

stretches of plain intervening wherein these species have never been recorded. As examples we can compare the lists of montane species given above for the Nilgiri and Palni Hills and we can add to these numerous species of Lepidoptera which are never found at low elevations even in the far North, such as *Danais nilgiriensis, Danais fumata, Colias nilgiriensis,* etc. Dotted about on the tops of all the southern Hills we find corresponding lists of species without any connecting links in the Plains separating them. In the majority of the species there is not the slightest variation discernible so that it is inconceivable that the faunæ do not constantly communicate with one another.

Standing on a prominent peak in the Nilgiris between the monsoons and surveying the neighbouring Plains and Hills, I have constantly been struck with the similarity between the latter and oceanic isles. In the height of the dry season a dense layer of murky, heat-laden atmosphere submerges the Plains and lower Hills. The upper surface of this " heat-haze " as it is often called, is wonderfully uniform and flat, in fact as sharply defined as any marine horizon. As far as I have been able to judge, this haze belt sharply demarcates the lower limits of montane species and I surmise that descent into it means to them submersion, drowning and death. Emigration from hill to hill must constantly and unseen be taking place across and above this sea of haze. A good instance of this is *Hemicordulia asiatica* which was first recorded from the hills of Assam and subsequently rediscovered by Mr. Bainbrigge Fletcher in the Palni Hills and a little later by myself in the Nilgiris. I have no doubt but that it will also be found on the lake in Newara Eliya, Ceylon. This species has never been found in the Plains and must wing its way from hill to hill far above the heat-laden atmosphere of the plains. These peaks must be regarded as atmospheric isles whereon some species are insulated and develop specific values whilst others by continual emigrations prevent that variation which otherwise would inevitably occur.

Just as we find certain species of fish inhabiting shallows or the upper parts of the ocean's depths and others which are strictly confined to great depths where they are subjected to greater pressures, so we find in the atmosphere a fauna which is strictly confined to it, whilst others are just as strictly confined to the lower denser layers.

It is reasonable to suppose that the former are unable to support the heat and pressure they would be subjected to below and, if emigration takes place, it must be through the upper atmosphere. So effectual a barrier is the lower atmosphere that Hill-species are as much isolated as any organism living on a lonely ocean isle.

55.—EXTERNAL GENITALIA OF LAHORE DRAGONFLIES.

By HIRA LALL, B.Sc.

THE MALE SECONDARY SEXUAL ORGANS.

. *External genital organs of* Crocothemis servilia servilia.

Secondary sexual organs of second abdominal segment.—They are widely separated from the opening of the duct of the testes and lie in a depression on the ventral side of the second abdominal segment entirely outside the body cavity, having no communication with it. The second abdominal segment, like the rest, consists of a broad dorsal piece covering both the sides and the back—the Tergum and a narrow ventral piece, the " Sternum."

The Tergum consists of three chitinous sclerites. The first sclerite is larger than the second and is separated from the latter by an incomplete suture. The second sclerite is produced on each side into a lobe-like projection termed the " Genital Lobe.". The third sclerite is very small and narrow as compared with the rest and is least chitinous. It ends abruptly behind the genital lobe. . Covering the Tergum dorsally there are fairly long hairs. The genital lobes are flap-like structures with a smooth or sometimes to a small extent wavy arched free border. Long hairs are seen on it near the margin. The sternum consists of a single sclerite which is smaller than the first tergal one even. At the top the sternal border is produced on each side into an angular process which lies beneath the Tergum (2nd) and serves for the attachment of the muscles. The anterior sternal is produced downwardly into a structure known as the " Anterior Lamina," which is finely arched with long hairs projecting from its free border. There is a pair of *Genital Hamules*, lying one on each side of the Penis. Each is produced distally into an " external hamular branch " and an " internal hamular branch." The Hamules themselves resemble in shape a trapezium. The Internal Hamular Branch is small and stout, being first curved inwards, then gradually narrows down until finally it ends in a sharp black tip which points outwards. The External Hamular Branch is rectangular in shape and is covered over postero-laterally by the Genital Lobes. The Genital Hamules serve the purpose of holding the ovipositor and

keeping it in position while copulation. The Hamules are borne by a chitinous frame-work roughly W-shaped. The frame-work lies dorsally and is attached to the Sternum on its inner surface by the tips. Projecting from each side of the frame-work at about its middle is a knob-like projection which attaches itself below the Hamule. Borne mesially on the frame-work is a structure partly chitinous, partly membranous, and known on account of its shape as the "Triangle." In its natural position it lies beneath the Penis and the bulb just to be described. It is rounded at its angles, the apex especially being more rounded. The basal portion of the Triangle lies beneath the Hamules and affords a second point of support for the latter. The lower half of the triangle is extremely membranous. Lying over the chitinous frame-work and triangle is a conspicuous organ consisting of an enlarged basal portion, the Genital Bladder, and a rod-like distal portion, the Penis, the posterior half of which is bent upon the anterior portion. The *Genital Bladder* is flask-like, attached to the sternum of the third portion by its base. The ventral surface of this structure is at places chitinous and at places membranous. The chitin is deposited on a lower basal and upper triangular portion, the two areas being separated by a membranous portion. The basal portion is further divided into two parts by a median ventral partition arising from the base of the Genital Bladder. The Bladder possesses a small broad neck. The Penis is a very complicated organ and consists of three parts. The first portion is attached to the neck of the Bladder. It is fairly long and rectangular in shape. It is chitinous dorsally and membranous ventrally. The second portion of the Penis is longer and stouter than the first and is attached to the first portion by a distinct joint. This is also rectangular. It is perfectly chitinous on its sides as well as dorsally, but is membranous ventrally. Running through it is a chitinous tube which opens into the third portion of the Penis, which is separated off from the second by a thin partition and consists of two distinct sclerites together with a number of processes. The first sclerite of the third portion is a plate much broader than it is long and ends below on each side in a small rod-like process. Arising dorsally from this portion on each side is a rod-like structure known as the "Banner."

The second sclerite is distal to the former and is known as the Ring though it is hardly ring-like in shape. The lower portion is rounded and membranous, the upper portion is long and chitinous. Running in its interior is a rod of chitin. The sides of the lower portion are slightly notched. Posteriorly the ring is curved upwards. Lying dorsally to the Ring is a structure called the "Lobe" which is quite membranous and about the middle of the Ring. Thus the tip of the

Penis is guarded by the curving up of the posterior portion of the Ring, also by the membranous Lobe, and also by the "Banners."

The Primary Sexual organs consist of a small papilla-like protuberance situated between the ventral plates of the 9th abdominal segment. It is roughly triangular in outline, being rounded at the angles. The seminal vesicle is covered over by a pair of chitinous flaps or preputial folds which meet in the anterior dorsal portion in the middle line.

2. *Orthetrum sabina.*

The second abdominal segment is greatly dilated dorsoventrally and compressed from side to side. The Genital Lobes, which are protective in function, are fan-like in appearance, and are covered over by stout hairs. Their margins are finely serrated. There is a well developed anterior Lamina which projects and covers nearly one-half of the second joint of the Penis. In the middle the projection is notched. On either side of the median line of the anterior Lamina is a group of strong bristles but the margin and the rest of the Lamina are quite smooth.

The Genital Hamule with its two processes, the internal and the external, form a single compact triangular piece from the inner side of the posterior margin of which arises a small hook which represents the distal end of the Internal Hamular process.

The greater part or the whole of the Framework is covered over by the anterior Lamina so that in some cases it cannot be seen externally.

The genital bladder is large, its ventral surface being covered over by small hairs, and is chitinous. The first portion of the Penis is rod-like and rectangular. The second portion is smaller but broader than the first. It is strongly chitinous dorsally. The joint between the second and the third portion of the Penis is of the nature of a ball and socket. The first sclerite of the third portion is more or less triangular with a straight posterior border. On either side of this sclerite is a flap-like outgrowth. This divides into two portions, an outer and an inner, the latter being opposed to its fellow of the opposite side. Enclosed in this flap-like structure is the "Banner" which is rod-like with a concave bend anteriorly which becomes convex towards the end. Between the twist and the flap is another flap-like structure which is the "Twist," very small in this species.

Situated at the posterior edge of the first sclerite in the middle line is the second sclerite of the third portion of the Penis, the *Ring*. There are two types of Rings. One is semicircular in outline with a knob at the distal end. The second type of ring is conical. Coming out from the

Ring is a long thread-like hair. The Ring is very small proportionately and is protected dorsally by a large membranous semicircular Lobe.

The Primary sexual organs are as usual.

3. *Brachythemis contaminata.*

The Genital Lobes are broad and rounded, each studded with a large number of thick short bristles. The anterior Lamina comes over the anterior portion of the Penis and possesses a straight free border. On its surface are seen two groups (one on each side) of long hairs, rather bushy in appearance. The Genital Hamules are oval in appearance and have in their posterior region a small number of very fine short bristles. The Internal Hamular branch is strongly bent and points outwards. The flat External Hamular branch is placed at right angles on the Genital Hamule. The apex of the Triangle is rounded as in others, and from that the sides become concave first, after which they become convex.

The Genital Bladder is flask-shaped with practically no neck, the neck being provided by the first portion of the Penis. The second portion of the Penis is slightly longer than it is broad. The first sclerite of the third portion of the Penis is quite small in length, the breadth being equal to that of the second portion of the Penis. The Ring is a fairly big chitinous oval structure with its posterior margin curved upwards. Arising from the median dorsal line of the proximal portion are a pair of triangular structures, the Style. The styles meet in the median dorsal line. Both the sides of Ring and the Styles are covered over by large broad Flaps, the Banners, situated one on each side. The Ring is connected by two rods of chitin which, running obliquely, are connected in the region of the first sclerite. There is a broad oval membranous Lobe which fits tightly on to the posterior part of the Ring, so much so that a depression is caused near that end. From the interior of the Ring two or three chitinous threads come out. These threads are basally united.

4. *Neurothemis tullia tullia.*

The Genital Lobe is a slightly elongated flap with rounded free border which is studded with bristles. The anterior Lamina finely arches over the Penis. The proximal border of the Genital Hamule is distinctly notched. The Internal Hamular branch, which is fairly well developed, first curves downwards, then bends forwards and again downwards, thus ending in a sharp tip. The External Hamular branch is large and conical, the inner side being convex.

The Genital Bladder is mostly chitinous ventrally except in the middle where the bristles are seen to come out. The first portion of the Penis is rectangular in shape. The second portion is strongly chitinous laterally as well as dorsally, and is broader posteriorly. The lower portion of the Ring is broad while the upper portion is somewhat narrower. The Ring is membranous. From its dorsal surface arise two very thin rods of chitin, the Styles, which diverge posteriorly. The Lobe, which is quite membranous, ends where the broad portion of the Ring meets the narrow one. The Banners are Flap-like, ending in a sharp point.

5. *Acisoma panorpoides.*

The Genital Lobes are rather longer than they are broad. Their free margin is broken and appears to be denticulated. The anterior Lamina is finely arched, with hairs sticking out from its free border. The Genital Hamules are somewhat oval in appearance. The Internal Hamular process is well developed and is curved downwards and outwards, ending in a sharp tip. The External Hamular Branch is narrow in the proximal region, broader at the distal end. As in *Brachydiplax sobrina* the Triangle can hardly be so-called and it appears as if the Triangle is supported on a rectangular area.

The whole of the ventral surface of the Genital Bladder is chitinous while the dorsal surface is membranous. The second portion of the Penis has its anterior portion rounded, while posteriorly it broadens out. The tube which runs through this portion is swollen, but assumes narrower dimensions in the first sclerite of the third portion of Penis.

The first sclerite of the third portion of the Penis is the broadest portion of the Penis but it is of small length. Arising from this portion are strap-shaped processes, one on each side, the Banners, on the sides of which are seen small conical processes known as the "Twists." The second sclerite of the third portion of the Penis is tubular in shape, produced anteriorly into a pair of processes. Posteriorly from the dorsal side of the Ring are given off a pair of very slender thread-like processes known as the "Styles." The Ring is strongly chitinous, being depressed in the middle, with the result that the sides curve upwards. The "Lobe," as in the other species, is a flask-like structure slightly chitinous on the sides.

6. *Brachydiplax sobrina.*

The Genital Lobes are small and narrow having hairs of medium size sticking out from the free border. The anterior Lamina is deeply

notched in the middle while in a related species, *B. farinosa*, it is not so. The Internal Hamular branch of the genital hamule is small and thick with a broad base. The External Hamular branch is a flat round process. The Triangle is peculiar in shape; in fact, it is hardly a triangle. Its posterior two-thirds are rectangular, the anterior side being deeply arched and constituting the rest of the Triangle.

The chitinous ventral surface of the genital bladder is marked by a line running horizontally in the middle and another at right angles to this dividing the upper half into two. The first portion of the Penis is broad and is the largest piece of all. The second portion, which is strongly chitinous, is rectangular and is broader than it is long. The first sclerite of the third portion of the Penis is small and gives on its sides the "Banners" and "Twists." The Banner is membranous and minute while the Twist is conical. The Ring is cylindrical, the distal end bent upwards. The posterior portion of the Ring is less chitinous. The Lobe is like an oval membranous flap uniformly rounded posteriorly and lies dorsally over the Ring extending up to about its middle.

7. *Tramea basilaris burmeisteri.*

The Genital Lobes are a pair of broad oval structures, with their free border provided with thick rounded knob-like projections. The free border of the anterior Lamina is quite membranous and curls upwards. The Genital Hamule is almost inconspicuous. The External Hamular processes are triangular in shape. The Internal Hamular processes are enormously developed, with narrow proximal portion, the remaining portion being wide, until ultimately it ends in a sharp tip. The inner side of this enormously chitinous process is finely serrated. The Triangle is very chitinous in its upper part, the apex being knobbed.

The first portion of the Penis is fairly long and is of uniform width. The second portion is roughly triangular in shape and is strongly chitinous dorsally. The second portion of the Penis is represented by a pair of chitinous flaps, which are fairly large, one on each side. Arising from their postero-dorsal border are the finger-shaped "Banners," which are almost membranous.

The Ring is broad and angular in front while it narrows gradually to the posterior end which is rounded. The Ring is attached at its anterior angles with the first sclerite of the third portion of the Penis mentioned above. Seen projecting from the posterior border dorsally are a pair of membranous "Styles" which meet in the middle line.

The Lobe is very well developed and extends even beyond the styles.

8. *Trithemis pallidinervis.*

The Genital Lobes are feebly developed and are somewhat elongated. The anterior Lamina is very well developed and covers more than half of the Penis. It has a slightly broken free-border. In the middle the Lamina is seen projecting where it is slightly notched to some extent. The External Hamular branch, together with the Genital Hamule, form one broad piece. The proximal portion of the Internal Hamular branch is merged in the Hamule itself while the distal portion is seen as a small portion ending in a sharp tip. The Triangle is quite large in this species.

The Genital Bladder is a very large structure. The first portion of the Penis is the largest of all the three portions, and is rectangular as usual. It is small in length but is very broad. The tube therefore is small, wide, and opens in the beginning of the third part. The first sclerite of the third portion of the Penis is very small. From it arises the Banner, which is a small and slender process, and the Twist, which is a well-developed rod-like process. The Ring is very chitinous with a straight or slightly convex anterior border. It gradually narrows down until it ends in a flat distal border. Arising from the median dorsal line is another strong rod of chitin which is fairly thick and splits posteriorly into two very strong claw-shaped chitinous "Styles." The Lobe is broad anteriorly with a rounded posterior border and is covered over by fine bristles. The Lobe ends where the "Styles" begin.

9. *Pantala flavescens.*

The Genital Lobes are fairly large, rounded and depressed. The anterior Lamina is distinctly notched in the middle. The Genital Hamules are triangular chitinous structures. The internal border of the Genital Hamule comes down and meets the posterior border, thus forming a very small curved Internal Hamular branch.

The first portion of the Penis is as usual rectangular in shape. The second portion of the Penis is dome-shaped provided with a free posterior border. The chitinous tube is very well developed and is strongly compressed from side to side in its proximal portion. Distally it expands into a leaf-like portion. The first sclerite of the third portion of the Penis is notched posteriorly. The Ring or the second sclerite of the third portion of the Penis, is quite small and membranous, triangular in structure and covered over completely by the large triangular styles. The Ring with its styles lies in the ventral groove of the tube which runs in the second and third portion of the Penis. How and why the Ring should lie in this position I cannot say. There is no trace of Banners and Twists.

10. *Diplacodes* sp.

The Genital Lobes are small, oval in shape and possess a smooth free border. The anterior Lamina is arched as usual. The External Hamular branch is not clearly distinguished from the Genital Hamule and forms a rectangular structure with rounded angles. The Internal Hamular branch is in the form of a small bent chitinous process directed downwards and slightly outwards.

The Genital Bladder is flask-like, provided with a narrow neck. The second portion of the Penis is narrow in the anterior region, broad in the posterior. The first sclerite of the third portion of the Penis is fairly well developed and is rectangular in shape with its posterior border projecting in the middle. The Banners are a pair of triangular flaps situated one on each side. There are no *Twists*. The second sclerite of the Penis or Ring shows a remarkable adaptation in that it is strongly protected by a pair of large triangular "Styles" which completely enclose it. Seen ventrally the "Styles" join together to form one continuous plate. The Ring can only be seen by turning over the styles. Forming a lower protective layer of the Ring is the Lobe whose posterior margin is frilled. The Ring itself is small and conical. In this position the Ring is nicely protected above and on the sides by the strong Styles, below by the Lobe and on the sides by the large triangular Banners.

11. *Tholymis tillarga.*

The Genital Lobes are large broad oval flaps. Each arches over the proximal portion of the Penis and may sometimes be notched. The Genital Hamule is triangular in shape. The Internal Hamular branch is well developed, curved, first bent downwards and then outwards, where it ends in a sharp tip. The External Hamular branch is large and conical and is separated from the Genital Hamule by a distinct ridge.

The second portion of the Penis is strongly chitinous, especially the sides. It is broader and longer than the first portion of the Penis. From the first sclerite of the third portion of the Penis arise the large flap-like oval Banners. The Ring is a large oval structure, strongly chitinous, from whose dorsal wall spring the Styles which are broad at the base, tapering apically. From the interior of the Ring is seen a chitinous piece springing from the base and ending in thread-like structure. The Lobe is broad, oval and membranous.

II. Short notes on the External Female Genital Organs of Lahore Libellulines.

Crocothemis servilia servilia.—The vulvar scale, seen projecting from the border of the eighth sternite, is a flat oval structure of medium size

with a rounded posterior border. It corresponds to the fused anterior processes of Zygoptera. Situated on the ninth abdominal sternum are a pair of knob-like processes, representing the reduced median processes of Zygoptera. A flat arched plate is seen projecting from the end of the ninth abdominal sternum and overlaps the tenth sternum to some extent. From its free border hairs are projecting.

Acisoma panorpoides.—The eighth abdominal segment is dilated to some extent. The vulvar scale is a small plate, notched in the middle. The styles are a pair of small stumpy processes. Again another small flat arched plate is seen covering the tenth sternum.

Diplacodes sp.—The vulvar scale is a small flat plate. It is not notched. The styles are knob-like.

Brachythemis contaminata.—The vulvar scale is well developed, broadly notched in the middle. Styles are as usual. From the posterior border of the ninth sternum a rather membranous plate is seen to cover a portion of the tenth sternum. The posterior border of this plate is rounded. Long hairs are seen to be sticking out all over the surface of this plate.

Neurothemis tullia tullia.—The vulvar scale is a broad oval structure. The styles are a pair of very small processes. Another plate is seen covering the tenth sternum.

Trithemis pallidinervis.—The vulvar scale is very small, concave in the middle where it is slightly notched. Styles as usual.

Tholymis tillarga.—It is well developed, deeply notched in the middle. The styles are in the anterior region of the ninth sternum as a small conical processes. A long oval flap is seen coming over the tenth sternum.

Orthetrum sabina.—The vulvar scale is absent in this species. Only a pair of small styles are present on the ninth sternum.

As an abnormality I have found that in one case a Penis is attached to the posterior region of the eighth segment while the styles as usual are seen on the ninth sternum.

Pantala flavescens.—The vulvar scale is absent. A pair of styles are present on the ninth sternum.

Conclusion.

That the secondary sexual organs are very important from this point of view. Classification is quite evident. I will, I think, not be rash to conclude that the Penis of the Libellulines is very important and is, if not a specific, a strong generic character.

56.—METHODS TO BE ADOPTED TO MAKE THE INDIAN FARMERS BELIEVE IN THE INSTRUCTIONS FOR KILLING INSECT-PESTS.

By HARCHAND SINGH, L.Ag., *Agricultural Officer, Patiala.*

An Indian farmer, not unlike the general ring of farmers of other countries, is a man of very conservative ideas. Generally speaking, new methods to him are foreign methods and as such not suited to the land of his forefathers, who taught him to remember "*Naya nau din purana sau din*" (the present-day things last for nine days, while the old things last for a hundred days). He may nod appreciation or give a smile by way of pleasing us on hearing our advice but in his heart of hearts he is a sceptic and thinks that to follow our instructions is to follow the will-o-the-wisp. To force him to adopt our new methods is not only impossible but also dangerous. For, however efficient and effective a new method of combating an insect pest may be; a forced farmer is an unwilling worker and as such he is sure to meet with failure, which in his ignorance he attributes to the perverted methods of the Entomologist, and the story of the failure of the new method is circulated far and wide. A certain insect pest may have been causing serious damage to a certain crop from year to year and the farmer may have been noticing it from his youth to his old age but he has never cared to find out how it comes into being, what changes it undergoes in its lifetime and whether it really dies out when the crop has been removed. For example, in the part of the Country I live in, the sugar-cane borer is known to every farmer. Our people call it *kansua* but they know nothing about it except that it is a caterpillar. If required, they will go and fetch a specimen from their fields, but even an experienced old farmer will hesitate to receive the truth that the caterpillar develops into a moth. It is their firm belief that the caterpillar, like the snake, lays eggs and consequently it is hopeless to resort to "Light traps" to destroy moths. In one district of Patiala State, a hairy caterpillar known as "*Katra*" (which I believe is *Amsacta moorei*) had been doing great harm to *mung*, *moth* and *guar* of *kharif* crops for a number of years. When in 1921 I commenced inquiries, the farmers told me that the flitting about of white moths after the first rain of June was a sign that *Katra* would then descend from the sky. I tried to explain

to them that the white moths, which they noticed after the first rain in June, were the parents of *Katra*, but it was all in vain. "How could it be possible," they said, "the moths were so like pigeons and the caterpillars like snakes? Could ever pigeons bring forth snaky offspring? Oh, No, Sir, impossible, impossible." This talk was no surprise to me. I am the son of a farmer and in my school days I had worked with my father and other farmers in the fields. My father was looked upon as a veteran farmer, whom the fellow farmers consulted in their agricultural difficulties, but that a caterpillar ultimately turns into a moth was even beyond his knowledge and formed a part of mine, when I was in the Agricultural College.

However, after a long conversation, I advised the farmers to plough fallow lands in the months of December and January and then in May and June with a view to destroy that hairy snaky offspring of pigeons in the pupal stage and afterwards to destroy the moths by picking and by using light traps. I may mention here that in the case of light traps, a very cheap method was devised by burning the bushes found in abundance in the fields. I also collected the farmers in different centres and showed them, with the help of coloured plates and a show case, the different life-stages of the pest; but this, I am sorry to say, failed to bring home to them the fact that the caterpillar ultimately changes into a pupa and then puts on wings and flies about.

It is true that seeing is believing with the common people. So I thought of introducing some easy method of demonstration which the farmers could manage with the assistance of the local village officials. Accordingly I persuaded the headmen of the villages in which the pest had made great havoc with the crops to rear a few caterpillars. I gave instructions to the *Patwaris* (village land-record keepers) to assist the headmen to accomplish the object in view. The results, I am glad to say, were very satisfactory. The farmers now witnessed with their own eyes, how the little but destructive enemies of their crops change their forms and breed. They then followed the instructions issued by the Department to destroy the pest and the loss to the next *Kharif* crop was comparatively small. The farmers, who were thus convinced, proved of great assistance to the Agricultural Department by disseminating the knowledge they had gained under the guidance of the Department to other farmers.

Last year, the Collector of the District, at my request, arranged to have the pest reared in each village, where the pest was found, by village headmen and *Patwaris*, who were instructed to show the farmers the various stages through which the insect passes. In addition to the demonstrative work, coloured plates showing all the different life stages

of the pest in question and with notes describing methods of its destruction, have been sent to each village. These plates are posted high up on the walls of public buildings where the farmers gather together for their daily gossip. This has been found helpful to a degree. Practically, a very great majority of farmers, I am informed by the District Collector, is now convinced of the utility of the methods advocated by the Agricultural Department, and I am sure that the farmer will now begin to take an intelligent interest in the programme of the Agricultural Department, which it wishes to follow for the welfare of the farmers themselves.

My main point is that, when we are confronted with the difficult problem of educating a farmer in the methods of killing a pest in the stage in which he has not seen it damaging his crops, we must convince him that the pest passes through that particular stage at one time in its life-cycle. This means that we have to cover before him the whole ground from the larval to the adult stage and this can be done best by practical demonstration. In this respect I beg to lay before you a few suggestions which I trust will be found workable with modifications to suit the local conditions of each district, and they are as follows :—

(1) That in every village, the village *Patwari* and the headman should be made to rear such caterpillars as may be easily reared with a view to see himself and show to others that the same insect changes forms, quite different from one another, in its life-cycle. The co-operation of the Revenue Department is very helpful in this matter and I hope that the Revenue Department will always be ready to extend a helping hand in this work.

(2) That show-cases of local important insect pests should be kept with village *Patwaris*, and coloured plates containing important instructions for killing such pests should be posted high up on protected walls and beyond the reach of boys. Expenses on show-cases and such coloured plates can be met from the village common fund.

(3) In rural schools, it should form a compulsory part of the education of the 5th and 6th classes to rear some local insect pests. This, I am sure, will have a far-reaching effect. The boys will not only explain this most interesting subject to their parents but will generally benefit by the knowledge they have thus gained in the school, when they themselves become farmers, as the majority of the village school-boys leave the school after the 5th or 6th class and take to Agriculture.

(4) Last, but not the least important, is the maintenance of that attitude of the mind which is called tolerance and which every Agricultural officer is called upon to exercise in dealing with and educating the farmers whose utterances are sometimes rough and impolite although they are not really intended to be so. We must not only keep ourselves cheerful during the time we have to work amongst them but also keep them in good spirits by proving to them that our great object is to ameliorate their economic life, even at the cost of a little personal discomfort and inconvenience. Broad sympathies with the farmers and the practice of tolerance go a great way to ensure success to the work of the officers of the Agricultural Department.

57.—CO-OPERATION IN INDIAN ENTOMOLOGY.

By T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S.,
Imperial Entomologist.

There are many forms of co-operation in Entomology. The form which is most familiar to most of you is the co-operation needed between cultivators to induce them to tackle an insect pest over an area of scattered holdings, but the branch of co-operation to which I desire to attract your attention to-day is concerned with the mutual relationships between entomological workers in India.

At our Third Meeting, four years ago, we considered the whole question of the Organization of the Entomological work in India in connection with my scheme for a centralized Entomological Service and Institute, and this scheme was referred by the Government of India to the Local Governments and Departments concerned and these, for once in a way, were practically unanimous in accepting it. At our last Meeting, two years ago, I was able to announce to you that this centralized scheme had been accepted by the Government of India, which had addressed Local Governments on the subject, and by the time of this present Meeting I had hoped that some further progress might have been made. I regret, however, to say that on account of increasing provincialization and financial stringency Government have now abandoned the idea of an Entomological Service and have postponed indefinitely the creation of an Entomological Institute. Apart from my own disappointment at the non-fruition of a scheme to which I had devoted so much thought and labour, I consider that the indefinite postponement of an organized plan for reducing the present enormous annual wastage of the wealth of the country is at once retrograde and deplorable. However, the opportune moment has slipped by and it seems evident that no resolute action to check this wastage will be taken in the near future, if at all. We are only too well aware how little can be done with the present small and for the most part badly equipped staffs scattered all over India under various Governments and Departments, and it only remains for us to see in what way, by voluntary co-operation amongst ourselves, we can use our inadequate material to the best advantage, not only of the Governments or Departments under which they may be employed, but of the country as a whole. For I think we all of us realize that Entomology has no room for Parish Politics and that insect pests are no respecters of persons or political boundaries, so that concerted action and co-operation are required if

we are to make any real advance in all big problems. Co-operation, in other words, simplifies effort, as Entomology now-a-days is such a vast subject that the average worker has to specialize more or less and is thus apt to overlook results obtained by other workers in other branches of research or applied work, thus leading to unnecessary duplication and waste of energy, time, and money. Even the narrowest specialist cannot afford to stand alone and, the better a man is at his own particular work, the more likely he is to be able to point to another man who knows more about it than he does. Frequent interchange of ideas between different workers is therefore not only desirable but an absolute necessity. Meetings such as this serve this purpose to some extent but it is obviously impracticable to hold Meetings with the necessary frequency, and written communications do not always bring out points which may seem unimportant to one observer but which are seized on by another worker as affording just the corroboration he requires. For, as I have pointed out to you before, an accurate observation apparently trivial in itself so long as it is isolated, when added to other observations, joins up with them to build up a coherent whole. The isolation of individual workers in India as it affects personal interchange of ideas lends point to these remarks, and I need not dilate further on this aspect, but another point which concerns isolation and co-operation is the need for some classification of scientific knowledge. It is perhaps a truism to say that scientific knowledge cannot be used until it is classified so that the facts required are properly accessible to each inquirer, but it is a point which is often overlooked. The specialist who is familiar with the literature of his own special line of work is apt to forget that other workers, who are not especially familiar with his line of work, are not also acquainted with the literature and do not know where to find the published literature, which is usually very scattered. Even if they know where to find it, the publications in which it is contained are usually not accessible, for it is only the largest Institutes which can afford to acquire and maintain a real working library. Apart from published literature, there is a vast deal of unpublished information in the way of notes on life-histories, habits and occurrence, illustrations, etc., more so of course in the larger Institutes such as Pusa, Dehra Dun, Kasauli and Coimbatore, but all scattered and not available to workers at other places; much of this may be published and thus rendered accessible in due course, but a great deal must consist of isolated facts, not worth publication in themselves, but yet, as I have already remarked, capable of fitting in with other isolated notes on the same subject if they could be brought together, as of course they would be in a centralized Institute. Then there are our collections

which are required for reference and identification, for instruction, for study of occurrence, variation, structure, etc., for a permanent record of experiments and for corroboration of published statements. Each of these collections, however extensive in itself, is yet very incomplete, although often its incompleteness in one direction may be offset by the completeness of another collection in that direction. If the insect collections at Pusa, Dehra Dun, Calcutta and Coimbatore, for example, to mention only a few, could be brought together, such a combined collection, although still very incomplete as representative of the Insect Fauna of India, would yet be of infinitely more value from a scientific and practical point of view than are these same collections in their present scattered condition.

There are various other aspects of co-operation but I need only mention one of them and that is harmony. It is not only mutual aid but also mutual confidence that is required of all scientific workers. That both prevail amongst entomological workers in India has been, I think I may say, attested by these Meetings as well as by our mutual relationships at all times between the Meetings. We at Pusa are always ready to help to the best of our ability all other workers, whether in the Provinces or other Departments or amateurs, with advice, loan or identification of specimens, gifts of duplicates, references to literature, loan of literature, or in any other way possible, and we usually find that others are willing to help us in similar ways, and I sincerely trust that similar harmony may always prevail.

Now, to come to practical matters, in view of the unfortunate fact of non-centralization of entomological work, I shall be glad of suggestions from any of you regarding practical means by which we can make the best use of our present scattered resources. In other words, how can we best make use of each other for the prosecution of our own work, with due regard to the paramount interest of the country as a whole?

Can Pusa help the Provincial Agricultural Departments more than at present? Without an increase of staff I do not see that we can do much more than we are doing. We maintain at present an all-India collection and records and act to some extent as a publication-centre for the Provinces as well as for our own output. Our object is to maintain as far as possible a complete record of all Indian Insects, especially those of *economic importance and except those of importance only to* Forest Entomology. This record is maintained by (*a*) card catalogues of all literature, which is now in process of publication as the Catalogue of Indian Insects, (*b*) files containing all published or unpublished information, the latter being published as material accumulates, (*c*) an all-India collection of insects for study of distribution, occurrence,

variation, etc., and also of use for comparative identification of insects collected or sent in for naming, (*d*) a library, the books of which are available on loan to responsible outside workers. We also work out life-histories and control of such insects as are locally available or are brought or sent in from outside, but we do not duplicate provincial activities in regard to local pest control unless invited to do so. So far as we can with the limited staff available, we endeavour to act as a centre for all information regarding Indian Insects, from whatever point of view, and this information is rendered available both by publication and on inquiry. Beyond this, we can hardly go with our present staff, but we shall be glad of any practical suggestions for making our work more useful.

Can the Entomological Staffs of the Provincial Agricultural Departments help Pusa more than they do at present ? Personally speaking, I should like to see more information sent in, especially in the way of records and specimens of pests and of general collections. This used to be done to a much larger extent than is done at present and I would merely remark that, the more extensive our material is at Pusa in the way of collections and records, the more useful we can be to the Provincial Staffs. It often happens that an unknown insect turns up as a pest in one Province which may be well-known in other parts of India and, by sending it in to Pusa, we can often give some information about it. Even if it is new to us, we are generally speaking in a better position than the Provincial workers to get it identified by a specialist, as we are in touch with more workers than the Provincial expert usually is, and it frequently happens that we have more extensive material, and it is more satisfactory to the specialist to have the opportunity of examining such extensive material than only a few specimens received from only one part of India. Apart from pests, the Provincial worker has frequent opportunities of collecting miscellaneous insects which are probably of little interest to him and of comparatively little use when kept unidentified in his collection but which, if all incorporated in one large collection, would help considerably in extending our general knowledge of Indian Insects. It is not that we want to rob Provincial workers of their specimens, but the fact is that a great deal of such material is wasted at present until it is worked out and this is best done if it is studied as part of a larger collection. If any Provincial worker is interested in a particular group, it is again of advantage to him to know exactly where to apply for material for study, and we are willing to assist by loan of our material. Mr. Ballard, for example, had the whole of our Capsidae for study and Rao Sahib Ramachandra Rao has had all our plant-boring Anthomyiadae.

Can the Entomological Staffs of the Provincial Agricultural Departments help one another more than they do ? I think that the Provincial boundaries act rather as water-tight compartments and, except for the opportunities afforded by these biennial Meetings, the Provincial Staffs know very little of what is taking place in other Provinces. The Government Entomologists in the Punjab, United Provinces and Madras may be working on Cotton Bollworms at the same time, possibly duplicating results, each without knowing what the other is doing until a year or two afterwards when results are published. I know how difficult it is to keep in touch and how impracticable it is to keep in active correspondence with all other workers on the same line. At Pusa we receive copies of the monthly reports of work in the Punjab, Bihar and Madras and I send copies of my monthly reports to the Punjab and Madras for their information. It would not be practicable for each worker to send out his monthly reports to every other worker, but it might be possible, if every worker sent in a copy of his monthly report to Pusa, to have these all put together and circulated to all Provincial workers, either cyclostyled or otherwise.

Can the larger Institutes, such as Pusa, Dehra Dun and Calcutta, help one another more than they do ? We already afford one another all possible help by identification and exchange of specimens, loan of books, etc., and on a basis of present Staffs I do not think there is much scope for improvement in this direction. One change of policy that seems obvious is not practicable. I refer to the possibility that each of the larger Institutes might specialize in one or more groups of Insects. Suppose, for instance, that Dehra Dun specialized in Coleoptera and that all our Coleopterous collections were centred there. From a purely systematic viewpoint such an arrangement might be desirable, but it would constitute little aid to economy in libraries and it would not be practical from an applied standpoint, because beetles are not pests of forest trees only but also of agricultural crops concerning which the Dehra Dun staff would have no knowledge as regards the actual control of the insects which they identified. There would therefore at the best be delay in referring first to Dehra Dun to know what the insect was and then to Pusa or other agricultural centre to know what control to apply ; and we all know what is the result of unnecessary delay in dealing with crop-pests. It would be very undesirable to divorce the records from the collection and equally undesirable to keep crop-pest records in a Forest Institute, or *vice versâ*. I merely throw out the suggestion of specialized Institutes as one that has occurred to me but which I have rejected as impracticable, as possibly you may like to discuss this aspect.

Can anything be done to centralize official entomological publications, apart from economic leaflets and pamphlets of purely local interest? As I have often pointed out before, we suffer from an excess of means of publication in India, so that entomological literature is so scattered that it is difficult to gather together all that has been issued on a particular subject. The *Records* and *Memoirs of the Indian Museum*, the *Indian Forest Records* and *Memoirs*, the *Indian Journal of Medical Research*, and the *Pusa Bulletins* all contain entomological papers intermixed with other non-entomological matter, and in addition to these there are the purely entomological series of the *Memoirs of the Department of Agriculture* and such occasional publications as the *Catalogue of Indian Insects*. Now, with regard to all these at least, it is perhaps suggestive that they are all produced at the expense of the Government of India. Would it be possible to combine the entomological papers issued in all these into one publication? Again I merely throw out a suggestion for your consideration. Personally I doubt whether it would be practicable. In the case of papers in the *Indian Journal of Medical Research*, for example, it would often happen that they might be of interest both to the medical man and to the entomologist, and in the case of the *Indian Museum Records* faunistic papers, such as those dealing with the Chilka Lake or the Abor Expedition, would suffer if the insect portion of the fauna were described in another place.

I shall be glad of any discussion on these or other questions regarding co-operation in Entomology in India. In any case, we must remember that Entomology deals with business problems and must be put on a business basis, and good business is based on good organization. It is up to us to show Government and the people of India that we are making the best use of the resources that we have to check the wastage of national wealth caused by insect pests, and we can only make the best use of our resources by mutual co-operation in our work.

58.—PUBLICITY FOR ENTOMOLOGY IN INDIA.

By T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S.,
Imperial Entomologist.

The keen scientific worker in Entomology, as in other branches of science, is usually too occupied with the immediate problems connected with the work before him to be able to spare time or energy in other directions. We most of us spend our lives in endeavouring to solve particular problems—it may be in connection with purely systematic work, it may be in the working out of the life-history of an insect, it may be in devising practical methods of control for pests, or it may be in a combination of these or other lines of research—but, sooner or later, our particular problem comes into the domain of application and, as regards the work of most of us, it may be laid down that the solution of a problem does no good unless it is applied. We thus come up against that perennial problem of how best to reach the cultivator—or the medical or veterinary man, or the industrialist, or whoever we know to be concerned with the application of our work. That is an aspect of publicity with which most of you are already familiar; but there is another aspect, which deals with the bringing of at least some of our results before the General Public, which may not be directly interested in one problem but which is directly interested, whether it knows it or not, with other facts regarding insect life.

As a general rule, the General Public does not realize that entomological work is required or how it can be used in everyday life and indeed, as far as India is concerned the General Public does not even realize the existence of such a science as Entomology. One result is the present appalling waste of national resources caused by insects in a country such as India. Two thousand millions (two hundred crores) of Rupees every year is the estimate of this loss which I gave you at our last Meeting—more than the entire revenue of the Government of India. Another result is now becoming apparent and that is the danger that even the present very small amount of entomological work that is being done may be reduced or starved for want of funds simply owing to the fact that those responsible for providing the funds do not realize the importance of Entomology in the economy of the country. It is another example of the old fallacious argument, that insects are small animals and therefore they are of little importance. The losses due to insects are often unnoticed or taken for granted as a necessary evil even when they are

enormous and easily preventible, simply because those concerned do not know that any remedy can be had or to whom to apply for help. The waste due to insect attack should therefore be emphasized and the General Public should be taught to realize that much of this waste is preventible. The question is, how can this be done ?

Scientific publications do not reach the General Public, which does not see them and would not read them if it did see them. They are, however, very necessary if only to inform other workers in and outside of India of the results attained by various workers. With few exceptions, our publications are of a more or less scientific nature and are intended only for other scientific workers. From this aspect they are invaluable but they do not secure applied results amongst the people generally. To secure applied results mass action is necessary and the masses must therefore be interested.

Popular short articles in the newspapers can accomplish a good deal and should deal with such subjects as common insects, and interesting facts about them, how they live, the damage they do and how this may be avoided, and so on. It has been the practice to send to the Press for review publications such as books, Memoirs, Bulletins, etc., but as a general rule this has accomplished very little—either the publication is not noticed at all (often not even acknowledged) or parts of it are reproduced in a more or less mangled form. This is inevitable, as editors are busy men, usually with little knowledge of scientific subjects, and have not the time to make a thorough examination of such publications. I would suggest that, when publications are sent to the Press for notice, they should always be accompanied by a short abstract or description of the matter contained in them, written in a style to appeal to the General Public. Free distribution of such literature to all who are really interested is also very desirable. With proper precautions against abuse, the cost of such free distributions is remarkably small.

Posters and advertisements are practically unknown in India with regard to scientific work but should be used much more extensively to inform the General Public not only of particular facts, but where further information may be obtained. The Inquiry Columns of the Public Press frequently contain questions about the control of common pests and so on and there is evidently no inconsiderable section of the educated public who would like to have information on insect problems but who simply do not know to whom to apply.

Moving Picture shows have become quite a sign of the times in all large towns in India and the films exhibited must reach a very large mass of the public. Most of the Bioscope Companies, I believe, hire their films in order to give a frequent change of programme. Films

showing life-histories and transformations and habits of insects, control under practical conditions, and so on, presented in a popular manner with appropriate description and accompanied by a statement regarding the nearest entomological centre at which further details were available, would probably be popular and would also probably be exhibited free of charge.

Exhibitions offer another avenue of reaching the General Public. Mere rows of glass cases full of insects elicit little enthusiasm, but charts, pictures, and a few specimens carefully selected and displayed and described in an interesting and striking way, may often stir up an interest to know more about them. For, to make any progress in securing publicity, it is absolutely necessary to rouse an interest amongst the General Public, to make them want to know more about insects and to accomplish control of pests, and to be led to do so by their own personal interest. As Francis Bacon put it some three hundred years ago, "Nihil enim multis placet nisi imaginationem feriat" (*Nov. Org.* I. 77). To rouse an interest, we must try to strike the popular imagination. To do this, there is no need to exaggerate. There are plenty of striking facts ready to hand. The thing is to get them before the public, either in any of the ways I have indicated or elsehow, but anyway to try to get them there.

At the present time we seem to be moving in rather a vicious circle. To do more work and thus reduce the wastage caused by insects we want more funds to carry out research and demonstration and to bring results before the General Public, and to obtain further funds we require to convince the General Public of their necessity. In the meanwhile, we can only do what we can to place the practical benefits of a knowledge of Entomology before the Public and to do this—however undesirable or undignified such a course may seem to some of us,—we must face the lime-light and blow our own trumpets.

59.—SOME SUGGESTIONS FOR FUTURE WORK IN ECONOMIC ENTOMOLOGY IN INDIA.

By T. V. RAMAKRISHNA AYYAR, B.A., F.E.S., F.Z.S.,
Assistant Entomologist, Madras.

In any systematic attempt to utilise in a practical manner the knowledge gained of the different aspects of the science of Entomology that have a direct bearing on the Agricultural progress of any country, it is evident that the following ought to be the main items to be kept prominently in view and attended to in their chronological sequence in any ideal programme of work, *viz.*, the training up of men for this line of work, the observation and study of the insect fauna of the country and the investigation of the habits and life-histories of such forms that have an economic importance, the education of the farmer in the main features of the science, and finally helping him to utilise the knowledge so gained to control injurious insects and take advantage of the activities of those forms which are beneficial. If these ideals are satisfactorily attended to the Entomologist may be said to have carried out his mission successfully; but, it is needless to add, such a consummation is a thing which will take some generations to be accomplished.

Let us see, however, what has been accomplished so far in the main lines of work. In addition to the Imperial Entomologist and his staff at the Agricultural Research Institute, Pusa, there are at present a few trained subordinates in most of the major Provinces of India deputed to devote their time to Entomological work; but it is only three of the Provinces of this vast continent that have each a Government Entomologist with the regular status, freedom, and authority of a controlling officer. With regard to the study and investigation of insects, that a considerable amount of work has been turned out in this direction, may be found from the publications of the different workers on the subject all over India. The great majority of the important insects of India have been noted and a good number of these studied in detail. As to the last two items in the main programme, *viz.*, the education of the *raiyat*, and the attempts to make him utilise the methods of Applied Entomology, it is to be confessed that very little has been done so far. To those of us who are familiar with work of such a nature along new lines, the reason is not far to seek. It is neither neglect nor indifference, for every economic entomologist knows that these two items together form the real goal of the whole work and that the first few points in the programme are but preliminaries and accessories to the accomplishment

of the main theme. Unless some substantial headway is made in training up a band of capable men for this work, and before some knowledge of the more important insects of the country is gained, it will be rash to approach the farmer or help him to utilise the results of any investigations, in other words, as in human ailments, every injury caused to plants by insects has to be carefully diagnosed and studied before remedial measures are resorted to ; otherwise, in many cases the remedies adopted as a result of imperfect knowledge may prove worse than the disease. Thus during the past two decades a considerable amount of spade-work has been done to form a basis for the future. Though a period of two decades, or four, is nothing for the solution of many an important scientific problem we must admit that we are now come to a stage when the more serious, more telling and more utilitarian part of the work of the Entomologist has to begin. While the training up of new men and the investigation of insects in their different aspects should continue side by side for a very long time to come, I believe the time is now ripe enough for earnest beginnings to be made to approach the *raiyat* and bring home to him some of the facts relating to the applied part of the science. It is on this aspect of the subject, *viz.*, the future work of the economic Entomologist, that I venture to offer some suggestions in this paper. All my suggestions may be brought under two main headings, *Men* and *Measures*. For any work of this nature which requires not only a proper grasp of the subject to be utilized but also one which demands certain human qualities for controlling and carrying on educative and propaganda work outside the pale of scientific circles, we want the right sort of men. Men for such work must be those thoroughly acquainted with the different local conditions, able to move and converse freely with the farmers, realise their difficulties, understand their prejudices, and respect their feelings ; they must be persons who possess, more than anything else, the interest of the country at heart and sufficient enthusiasm and earnestness for the work. It is needless to add that if sons of the soil with these desirable qualities are found they will form the best medium to carry on the work satisfactorily. In a paper read by Messrs. Lefroy and Howlett before the International Congress of Entomology held at Brussels in 1910 on the "Progress of Economic Entomology in India" they have sounded the true note when they remarked thus, "Where there is a body of men from their own community trained in scientific agriculture, able to adapt it to the needs of the country and to the peculiar conditions of their agriculture, the benefits of scientific knowledge and its practical application might be put to them in a way they would appreciate and understand."

With regard to the position of the Entomologist in his dealings with farmers, a few suggestions may be offered. When any report of a serious outbreak of pests is received from any place the controlling officer himself or a subordinate of some experience and standing should try to visit the locality. A good deal can be done to satisfy the farmers by the controlling officer himself visiting the place, interviewing the farmers of the locality, and doing whatever is possible under the circumstances, and if nothing could be done in any bad case, he could easily gain the confidence of his clientele by personally explaining the practical difficulties in the way, and thereby convincing them of the sincerity of his attempts. It is a very bad policy to send a raw recruit or a novice in the art in response to such reports, simply as a sort of formality; in my opinion it is not only false economy, but in many such cases, due to the want of tact of the young men, the reputation of the entomological section itself does suffer. The Entomologist should never give indifferent advice, nor should he suggest methods which are quite impracticable and unsuited to local conditions.

I believe, I have sufficiently dealt with the first point—the men and their requirements for the work. We will now come to some suggestions *re* the "Methods." Now that a fair amount of spade work has been done during the past two decades, it is the duty of the Economic Entomologist to keep the educated farmers frequently informed of the work he is doing. He need not be told regarding details of any work, but it is certainly up to the scientist to explain or indicate to him the line of work and the object with which it is done in a popular manner. For instance, in Entomology with the bulk of preliminary work done so far, a good deal in the way of information may be given to the *raiyat*. This may be done in different ways. One way is by issuing popular leaflets in English and in the Vernaculars. With regard to insect leaflets, I might emphasise the fact that they are more appreciated if well illustrated with diagrams; as a matter of fact, a good diagram will explain facts regarding insects much more than pages of explanation. For example, small and popular leaflets on some of the more important insect pests of the Province, their geographical distribution and the approximate seasons when they appear, might be issued. There is no doubt that a small readable primer in the Vernaculars containing lessons on elementary facts in the life of familiar Indian insects for use in rural schools will considerably help in the education of the future generation of *raiyats* in such matters. To supplement the above method of disseminating information regarding insects, what is called "Extension work" in the West may be adopted. This method consists in sending round as a matter of routine a few trained and experienced Entomolo-

gists chiefly to visit agricultural tracts and speak to farmers in their various meetings such as *panchayats*, Co-operative societies, market places, etc. and demonstrate to them the different methods of applied Entomology which are suited to each tract. This method of giving information to the *raiyats* is certainly far more effective than the issue of publications. The issue of the leaflets should be done by these men doing district work, after promptly explaining to the public the contents of each publication. This second method might include giving lantern lectures to farmers and rural school boys, demonstrations of life-history stages of important pests with actual live specimens collected from the fields, and demonstration of practical methods of control. Without fear of contradiction I might state that hardly another branch of Agriculture demands as much moving about the country on the part of the scientist as Entomology, as it is more a field science than a laboratory experiment, and the money spent on such itineraries will be found in the long run to be very well used.

Speaking of demonstration of methods of control, I might add some suggestions as to the ways in which they could be done with our present limited knowledge of that aspect of the science. Of different kinds of control measures there are three well-known kinds, *viz.*, Agricultural, Mechanical and Insecticidal. In the lay mind of the country farmer casual suggestion of methods of an agricultural or mechanical nature, though extremely effective and economical in many cases, fall flat and do not create as favourable an impression and spectacular effect as the use of drugs and novel methods. It is usually the case even with regard to doctors when, instead of giving some medicine or other to the patients, they prescribe diet, etc., and other simple methods. Therefore the Entomologist has to actually prove the efficacy of such of these methods which are really practicable and economic by actual demonstration. Methods like handpicking, netting or flooding the field, are extremely effective in some cases. For pests like Sphingid caterpillars, the Citrus leafeater, Epilachna beetles, etc. handpicking is pre-eminently economic, especially because the larvae and their eggs are spotted out very easily. For Blister beetles, bugs like the rice *Leptocorisa*, red gram *Clavigralla* or the cow-pea *Riptortus* and grasshoppers of sorts on low-growing crops, there is nothing so effective and cheap as the use of hand nets or sweeping bags. Cutworms and swarming caterpillars like those on paddy, tobacco, *Sesbania*, etc., may be checked effectively by flooding where water is available. Whenever possible, these simple methods should be demonstrated and a better impression regarding them created in the minds of the cultivator. With regard to insecticidal methods, of which spraying is the chief, it may be laid down

once for all, that in India, except in cases of some pests that affect paying crops like fruit trees, cotton, tobacco, coffee, tea, and garden and kitchen plants on a small scale, such methods are absolutely impracticable in every way. For pests of staple food and other crops like paddy, millets, oilseeds, etc., grown on an extensive scale, insecticidal methods will be of no avail and the Entomologist should never suggest these. But in the case of fruit trees spraying will certainly pay, and the Entomologist could easily gain the confidence of orchardists in India by demonstrating such methods to them. This has been done to some extent in some cases, *viz.*, the mango-hopper in Salem, Chittoor, etc., and the tobacco Aphis, chiefly in S. Kanara, and the effect has been extremely satisfactory. Spraying could certainly be recommended to such paying crops, and the success resulting from such attempts will go a great way to gain the confidence of the cultivators. For this purpose spraying machines may be stocked by co-operative societies and lent on hire to gardeners of adjacent villages. Nor should the Entomologist in his zeal to push forward new and novel methods forget that there prevail in many parts of the country different local practices to control insects, some of which are extremely efficacious. In a paper which I read before the Indian Science Congress at Nagpur, "On some local methods regarding insect pest control in S. India," I have described some of these practices. The Entomologist must try them himself and introduce them to other parts of the Province where such methods are not in vogue.

Before concluding, I wish to touch very briefly on one or two other points in this connection, one of these is that there should be some decentralisation of entomological work in some of the major Provinces, specially in Madras so far as I could judge. The centres of Entomological work in each Province should be more than one, specially in view of the large area, the differences in the Agricultural conditions and pests of different tracts and the economy and the promptness in dealing with local pests.

The other point I wish to touch upon is the necessity for deputing one or two experienced hands from the Entomological Department of each Province to foreign countries like the United States, Great Britain, Java, Philippines, West Indies, etc., to get some ideas of methods of work done in those countries, where entomological work has considerably advanced; these men could add a good deal to their local experience, and would prove on their return extremely useful to the country with the supplementary knowledge gained from abroad. Economic Entomology being quite a new science to India, this practical

experience of work done in this science in other countries is more or less essential for the progress of work on correct and up-to-date lines.

Discussion on the Papers in Section XI.

We will take all the papers in Section XI together. As they cover more or less the same ground, the discussion on all of them had better wait until the end.

Proposed the following Resolution regarding teaching of Entomology in the Universities :—

" That this conference recommends to the Indian Universities that Entomology be taught as a separate subject of equal rank with Zoology, Botany, and Geology in the courses of study for B.A., B.Sc., and M.Sc. degrees."

Dr. Kunhi Kannan urged that the diffusion of knowledge of Entomology should be more general. In the present courses in Zoology, Entomology was barely mentioned, with the result that students completed their scientific courses of study knowing very little of this increasingly important subject. The interest of the students, many of whom were of the landowning classes, to whom Entomology was of great practical importance, was not aroused, and would not be aroused unless the subject was more adequately dealt with in the Universities. The body of official and unofficial Entomologists at the Conference was best fitted to urge upon the Universities the need that Entomology in India should now be given the status which its growth in recent years warranted, and which had already been accorded it in Europe and the United States of America.

The result of such action would be of great advantage to this country. Apart from the wealthy classes, the teachers in schools would go out with a knowledge of, and interest in insects and this knowledge would filter down, through the nature study classes to the sons of the cultivators who would then be better able to understand and put into practice the advice given them for the control of insect pests in their fields.

In supporting the resolution, spoke as follows :—

So far the main attempt of the Agricultural Departments in the Provinces has been directed towards increasing the yield per acre of land, be it through better seed, superior varieties of plants, modern methods of tillage, suitable manures, or introduction of machinery. Exceedingly little has been done, or is being done, to study the causes which are directly responsible for diminished outturn, or reduction of the produce.

To try to produce more without safeguarding what is produced is certainly a fruitless attempt. In fact, without *organized* attempts to

control factors which directly reduce the yield or nullify the advantages of increased output, one cannot talk of agricultural progress. Yet this is the attitude most prevalent in the Department and in the outside public, and our educational institutions are not above it.

While Agricultural Zoology has been recognized as an important branch of agricultural training in most of the Universities and Agricultural Colleges in England, which is not primarily an agricultural country, with us a knowledge of insects and other animals, useful and harmful to man, his domesticated animals, his crops, his fruits and his other possessions is not regarded as an essential part of the education of a trained agriculturist, even when the agricultural course may extend to four years. It is imperative that the graduates in agriculture of our Universities should know all about the gametophyte and sporophyte generations of plants, must have full mastery of the theories of physical chemistry, yet of insect pests and their control they may be absolutely ignorant. And the problems, which any cultivator, or an estate manager has to face, are either agricultural or entomological. He can get his chemical and even botanical problems solved by others, but he must solve his own entomological problems. Every student of Agriculture is taught to eradicate weeds, yet we regard animal pests as of no significance. A farmer or a fruit-grower may produce an excellent crop without any scientific knowledge of how plants obtain their food and how they breathe and yet he cannot be a successful farmer or a fruit-grower without being able to recognize his insect foes and without dealing with them effectively.

I might say without fear of contradiction that in all the Agricultural Colleges in India, Agricultural Zoology (including Entomology) is regarded as a minor subject and receives very little attention. The result is that our trained agriculturists are no better than illiterate cultivators in regarding all insect pests as uncontrollable plagues which have descended from the Heavens to punish the wicked. This is the result of our defective system of agricultural education. We teach a student in the Agricultural College—if not in theory, in practice; if not by written or spoken word, by example—that the knowledge of insect pests is not an essential equipment of an agriculturist, and naturally he attaches very little value to insect control.

In the Punjab Agricultural College, Lyallpur, the course preparing students for the B.Sc. (Agri.) degree of the Punjab University extends over four years. While Agriculture, Botany and Chemistry are taught for the full four years, Zoology, Physiology and Entomology are squeezed in the first two years of the course. This is because Entomology has been called a 'minor subject.' In about 80 lectures one is

supposed to teach to matriculates, in a foreign language which they cannot understand properly, Elementary Zoology and Animal Physiology sufficient to form a basis for animal breeding, animal feeding, and Veterinary Science, as well as teach them Pure and Applied Entomology, not leaving out Sericulture, Lac growing, and Apiculture. We have also to lecture to the students about insect carriers of disease.

The ignorance of the masses, which has been alluded to so often, is certainly a great hindrance in our way, but the real brick wall in the path of our progress is the appalling ignorance of those in the Agricultural Department, who do not recognise the real importance of Agricultural Zoology and Entomology. We as a Department pride ourselves, if by proper cultivation or by improved varieties we can increase by a small quantity the yield of a crop, yet we are unmindful of the fact that in sugarcane alone, and that only from the attacks of borers, as estimated by you, Mr. President, we lose annually Rs. 30,00,00,000. Does this not nullify all the good done, does it not mean that the energy spent and the capital lost in producing more has been entirely wasted?

Far be from me to deprecate scientific training of any kind, but in professional education every science must receive proper attention. We as students of Entomology must urge that Agricultural Zoology (including Entomology) should be given its rightful place in the curriculum of the Agricultural Colleges and be regarded as of equal status with Agricultural Botany and Agricultural Chemistry and be included in the degree courses.

I have great pleasure in seconding the resolution moved so ably by Dr. Kunhi Kannan.

In opening the general discussion, remarked that it was difficult to impress the cultivator with recommendations for treatment unless one had a solid foundation of research behind the advice given. The cultivator was apt to ask for information about other questions than the one in hand, and if the answers failed to satisfy he was likely to conclude that none of the advice tendered was of much use. He said :—

"As regards Mr. Ramakrishna Ayyar's suggestion of stationing a number of officers of independent status at different places in the larger Provinces, this is entirely opposed to my ideas on the need for centralisation. Such a measure of local decentralisation could not fail to prove expensive and inefficient, and to result in much duplication and overlapping.

"I am entirely in sympathy with the spirit of Dr. Kannan's resolution. My only criticism of it is that this is an unpropitious moment for bringing it forward. In view of the present financial situation it is very unlikely that any University would be prepared to consider the

establishment of a new chair in Entomology. Those Universities which already have an Entomologist on their staff might however be willing to give Entomology equal standing with other branches of Biological Science."

A general discussion then took place upon the question of the status of Entomology in Indian Universities and Agricultural Colleges. As a result of this, Dr. Kunhi Kannan amended his resolution which was seconded by Mr. Husain and passed as follows :—

"That this Meeting recommends to the Indian Universities that the subject of Entomology be taught as of equal rank with other branches of biological science in the courses of study for the examinations of the Universities for degrees in Science including Agriculture."

Discussion on Co-operation and Publicity.

Two points in which the Provincial Entomologists may make use of Pusa to their advantage occur to me.

Interesting observations of the nature not warranting separate publication must frequently be made in the course of our work. Such observations, although they may appear perhaps trivial to us at the time, may prove of importance if collected and correlated at headquarters and should be transmitted to Pusa for record and filing. Should they later be deemed suitable for incorporation in a Pusa publication, this could then be done. It would perhaps stimulate officers to submit such notes if in the publication the source of origin was mentioned.

In the matter of collections my own opinion is that the Provincial Entomologists, unless they are specialists in particular groups of insects, do not require to burden themselves with the labour and responsibility of maintaining large collections of insects. I consider that all general collections should be submitted to Pusa and only a compact collection for purposes of demonstration and identification need be maintained in the Provincial headquarters. To meet the case of the present diffuseness of publication of the Entomological literature, would it be possible to divide all Indian entomological papers under two heads, namely, Economic and Systematic? The Economic section would include all branches of Applied Entomology and might be published either from Pusa or by a joint board of the Departments interested; while the Systematic material might perhaps conveniently be issued from the Indian Museum.

In continuing the discussion on the subject of Cooperation in Indian Entomology, I wish to repeat that I am asking for suggestions. The Staff at Pusa is limited but is always ready to do what it can by way of assisting Entomologists attached to Provincial and Indian States Departments of Agriculture and any others who are interested in this science.

So if you have any suggestions as to ways in which we can be of further use to them I should be glad to hear them. I should also welcome suggestions as to how you in the Provinces can further assist the Central Institution.

Let us for the moment forget that there is financial stringency, which we hope may shortly be relieved, so that we may consider what we should like the Central Institute to be able to do. The Staff at Pusa is now engaged mainly in systematic work and research on bionomics of the insects in general. The Central Institute should undertake all investigations of general problems of all-India importance leaving particular problems of local interest to the Provincial Entomologists and eliminating much of the danger of overlapping. It would be of great help if Pusa could take up the questions of standard insecticides, standard methods of fumigation and the investigation of control of insects of all-India status, of stored grain pests. The systematic work should be extended and centralized, all Provincial collections coming to Pusa for identification and the return of named duplicates.

I agree with the need for a Central Institute to tackle the problems of insecticides and fumigation. We have to depend largely at present upon Western methods devised under different conditions which do not always work when applied to India. If investigations were undertaken by the Imperial Staff we should then obtain correct advice as to materials and methods applicable to Indian conditions. Also it would then be possible to arrange for preparation in India of standardised materials.

I have listened to the suggestions of spraying and fumigation work to be done at Pusa but I think the question of spraying apparatus is just as important as any of these and suggest this should also be included as an item of work for Pusa.

As a representative of the Amateur Entomologists in India I must express our gratitude for the help which is so readily accorded us from Pusa. I wish all the unofficial Entomologists in India to realize the amount of help which awaits them if they will only apply for it.

I do not know how far advantage has been taken by other workers of the offers made by Mr. Fletcher but I personally feel that I am under great obligations to the Imperial Entomologist for the aid that he has accorded me. So far the discussion seems to have been occupied largely with the question how further Pusa can assist the Provinces. I feel that there is an enormous amount of work thrown onto the Staff of the Pusa Research Institute and that it is our duty, if possible, to relieve the Imperial Entomologist of some part of this. I am very willing to do what I can and shall be glad to be informed if there is any way in which I can be of any assistance to the Agricultural and Medical Entomologist.

The Forest Entomologists are already assisting on the matter of the Catalogué of the Indian insects. One way in which help may be rendered is by collection of many groups made in the out-of-way places which Provincial Officers and particularly Forest Officers have facilities of visiting.

So far we have considered only cooperation between Entomologists; it is equally important that we should cooperate with scientists in other branches of work. At present such cooperation is non-existent. I therefore suggest that if Entomological Meetings were held at the same place and time as the Indian Science Congress, this would afford the opportunity for discussing problems of broader interest touching on Entomology with Botanists, Chemists, and the like. While relieving the staff of Pusa of a part of the labour entailed in preparation of the Entomological Conference, it will also tend to economy in travelling now requisite for the officers who wish to attend both the Science Congress and the Entomological Meeting.

The suggestion might be feasible if the Indian Science Congress were holding sessions at some place which were the Headquarters of an Agricultural Department.

I am strongly of the opinion that the Entomological Meeting should for many reasons be held at the Central Institute. If we want Pusa to retain its status of the Central Institute for Entomology we shall be, I feel, unwise to suggest that the biennial Meetings can be held as well elsewhere. Pusa at present affords opportunities of discussing our problems with workers in other fields of research far greater than would be afforded by association with the Indian Science Congress.

I shall personally be very averse to transferring the Entomological Conference from Pusa. We have here the opportunity to consult collections and the library which could not be afforded elsewhere and for which a separate visit to Pusa would, with many of us, be impossible. I fear that, were we to join forces with the Indian Science Congress, another great advantage of our Meetings would be lost, namely, the opportunities we have, by being held together in a small area, of discussing with one another our problems, not in the regular meetings of the Conference but informally outside these Meetings. Were we to be merged in the Indian Science Congress the forces would be scattered over a bigger place and our interests would perhaps be deflected from purely entomological matters by the varied subjects under discussions in the Indian Science Congress.

In this connection I might perhaps say that the Entomological Meeting is a branch of the Board of Agriculture and that we are not free agents in the matter of the locality for our Meeting. When the

Entomological Meetings were originated, it was the intention that they should be held alternately at Pusa and the Provinces, but so far the latter course has not proved practicable, but perhaps the time may be ripe for a change of venue for the next Meeting. I do not think it would be practicable to hold our Meetings at the same time and place as the Indian Science Congress. The Board of Agriculture Meetings, which alternate with our own, cater for just that cooperation and joint discussions with other branches of Science which Mr. Husain desires.

Would it be possible to hold the Entomological Meetings immediately after the Indian Science Congress so that the entomologists wishing to attend both will proceed from one to the other?

Mr. Husain has argued very ably in favour of associating the Entomological Meetings with the Indian Science Congress. While he was speaking I wondered whether I should not borrow his arguments for presentation to the Veterinary Conference now shortly to be held with the idea of establishing a Veterinary section also of the Science Congress. But in view of the fact that Entomology and Veterinary Science are regarded, very erroneously, as minor subjects, as Mr. Husain has previously pointed out, we should approach with extreme caution this question of merging ourselves into the Indian Science Congress. I fear that there too, our branches of science will be regarded as minor subjects and that we should be in danger of losing the individuality which our present detached Meetings ensure. For this reason, I am personally opposed to such a measure and if I may presume to the Entomologists assembled here, I should warn them against taking any such step.

The following Resolution proposed by Dr. Kunhi Kannan and seconded by Mr. Iyengar, was discussed and passed unanimously :—

"That, in view of the great value of these conferences to Entomological workers in India and elsewhere, this Meeting is of opinion that the biennial Entomological conferences should be continued in order to afford facilities to workers in all fields of Entomological research, to meet and discuss the work in their respective fields."

60.—A FEW INSECTS USED AS FOOD IN BURMA.

By C. C. Ghosh, B.A., F.E.S., *Assistant Entomologist, Burma.*

(Plate 36.)

The following notes are intended merely to record the facts which ave come to my knowledge in the course of my work. It may be stated ere that Burmans, Karens, Chins, Kachins, Shans, Talaings and others habiting this Province are not at all fastidious in the choice of food and onsequently many insects have found a place in their diet. A Buddhist, lthough averse to taking life, has no objection to eating any animal hich has been killed by others. Many Burmans (of course who are ot orthodox) kill insects, etc., for themselves as well as for sale. The isects mentioned here by no means form a complete list.

Lefroy mentions the Dytiscid beetle *Eretes sticticus* and its grub and *ecophylla smaragdina* as being used as food in Burma. As regards the ormer, there is nothing more to add to what is recorded in *Indian Insect ife.* The nests of *Oecophylla* are collected and the ants, grubs, etc., re suffocated to death in an air-tight vessel with smoke. The ants, rubs, etc., are then picked off and made into a paste which soon gets our and is called *Khagyin.* The nests are therefore called *khagyin ök. Khagyin* is eaten especially by women who believe that it is good or their monthly period.

The large brown cricket (*Brachytrypes portentosus*), called *payit* i Burma, is very largely used as food and is sold at the Mandalay market or this purpose in a fried condition, being then known as *Payit-kyaw* iterally, fried cricket). The crickets are collected by some people in he villages who may be described as professional collectors. In some illages in the Madaya subdivision of the Mandalay district ten large rickets sell for two annas. In the Mandalay market the price of *'ayit-kyaw* is one rupee four annas for 100. Large quantities of these ied crickets, sometimes basketfuls, are used occasionally by rich people o feed others, including *hpoongyis* (Buddhist monks).

Oryctes rhinoceros grubs are said to be considered a delicacy by the Karens. A Burman, who was turning over a dung-heap for me at Hmawbi or these grubs, described that he and many others ate these grubs after rying them. The dark hinder parts of the grubs are rejected. Among these grubs those of *Xylotrupes gideon* are included.

Rhynchophorus ferrugineus grubs, usually called the *on-po* (*i.e.*, coconut insect) are liked by all, and, not being very easily procurable, have a right to be considered a dainty. They are boiled, when the skin separates and this is rejected. The taste is described by those who have relished it as that of boiled coconut milk. I am told by several Burman gentlemen that these grubs occurring in *Phoenix acaulis*, and known as *thimboung-po* after the plant, are fattened by being put inside ripe coconuts from which the water is first of all taken out. A fattened grub may cost as much as eight annas.

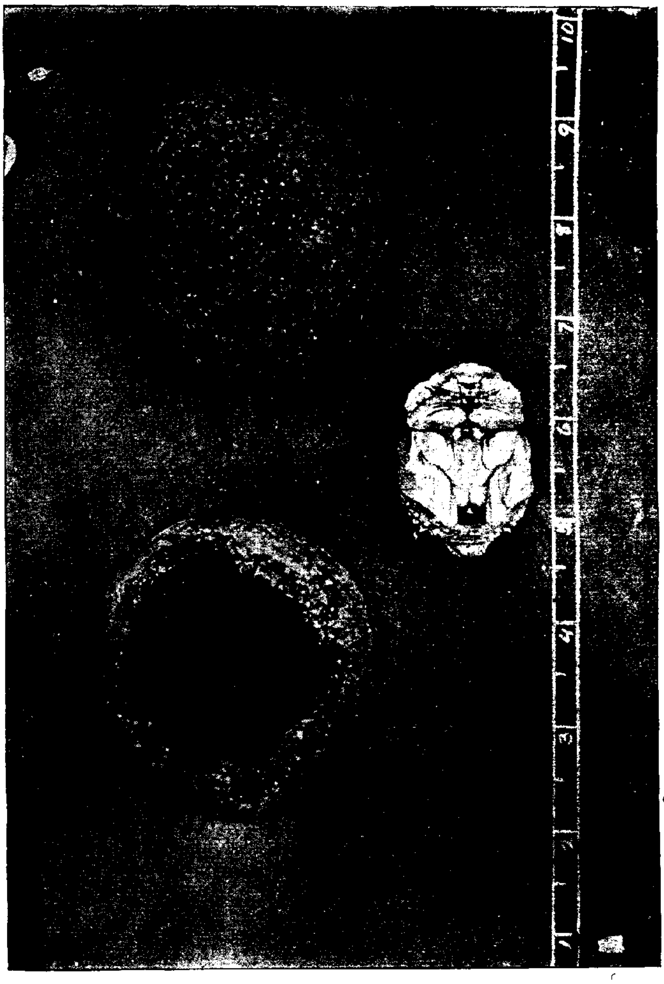
Heliocopris bucephalus pupae, known as *shwe-po*, are in great demand among the Shans and each pupa may fetch a price of one to one-and-a half annas. About March-May it is very common in the Shan Hills to find Shan men, women and children going about digging different places in search of the pupæ, which are found inside round balls of agglutinated earth (see Plate 36) at a depth of about one to two feet. These people seem to know as if by instinct where these balls are present by an external examination of the surface where usually a hole is observable. They say that when the cuckoo begins to sing it is time to dig out the *shwe-po*. The mother beetles carry down cattle-dung and deposit eggs in it underground. The grubs feed on this dung and then pupate inside these balls. I have seen up to seven balls being taken out of one place and it is said that up to a dozen or more may be found together. From some balls collected on 5th May beetles emerged in the laboratory between 9th and 16th June and died at the end of the same month. The beetles have been collected practically throughout the year. It is not definitely known when oviposition takes place on a large scale.

The various kinds of grubs found in the droppings of cattle in the rainy season are collected and eaten by many. Sometimes the various kinds of beetles coming to light are collected with lanterns in the fields and are used and even sold for food.

Cerambycid grubs found in logs of wood are dried and preserved in oil and eaten with *laphet* (Burmese tea).

Winged termites are eaten in many places, boiled or fried, the Southern Indian Coolies also indulging in them.

Grubs, pupæ and eggs of honey-bees are boiled with the parts of the combs in which they are contained and made into a soup which is relished by many. At Maymyo honey bees are troubled by a wasp, locally called *padu* (apparently a variety of *Vespa auraria*). The wasps hover in front of hives, catching and killing bees as they fly out of or into the hive. They are common in the rains and early winter but disappear in winter. They build large oval or round nests which are hung on branches of trees or bushes. When accessible, the Shans smoke these nests at night through



Heliocopris bucephalus, **dung-ball entire (right) and opened (left), and pupa. Scale in inches.**

their single entrance holes, thus stupefying the wasps inside. The nests are then broken open and robbed of the grubs and pupæ, which are eaten. Wasps building nests underground are similarly treated.

Silkworms are eaten in a fried condition and may be stored for future use, being boiled when required to be eaten. They are known as *Po-gaung-gyaw* and sell for one to one-and-a-half rupees per *viss* (3½ lbs.). Not a single silkworm pupa is wasted, it being ready to be eaten as soon as it comes out of the reeling pan in the boiled condition. It was a delightful sight to see little children come begging for such pupæ from the Indian reelers who were engaged in the Prome district among the Yabeins. The boiled pupæ relieved the monotony of the girls being trained, who had a ready dish to be carried home after the day's task was done. In the Karen Hills a dish of pupæ was offered to and readily partaken of by the Town-Officer (a Karen gentleman) who visited a silkworm rearer's house with me where reeling was being done. Presents of such pupæ were said to be made to him very frequently.

61.—A NOTE ON DIMORPHISM IN *PUNDALUOYA SIMPLICIA*, DISTANT (DICRANOTROPIS MAIDIS, ASHM.)*

By Rao Sahib Y. RAMACHANDRA RAO, M.A., F.E.S., *Acting Government Entomologist, Madras.*

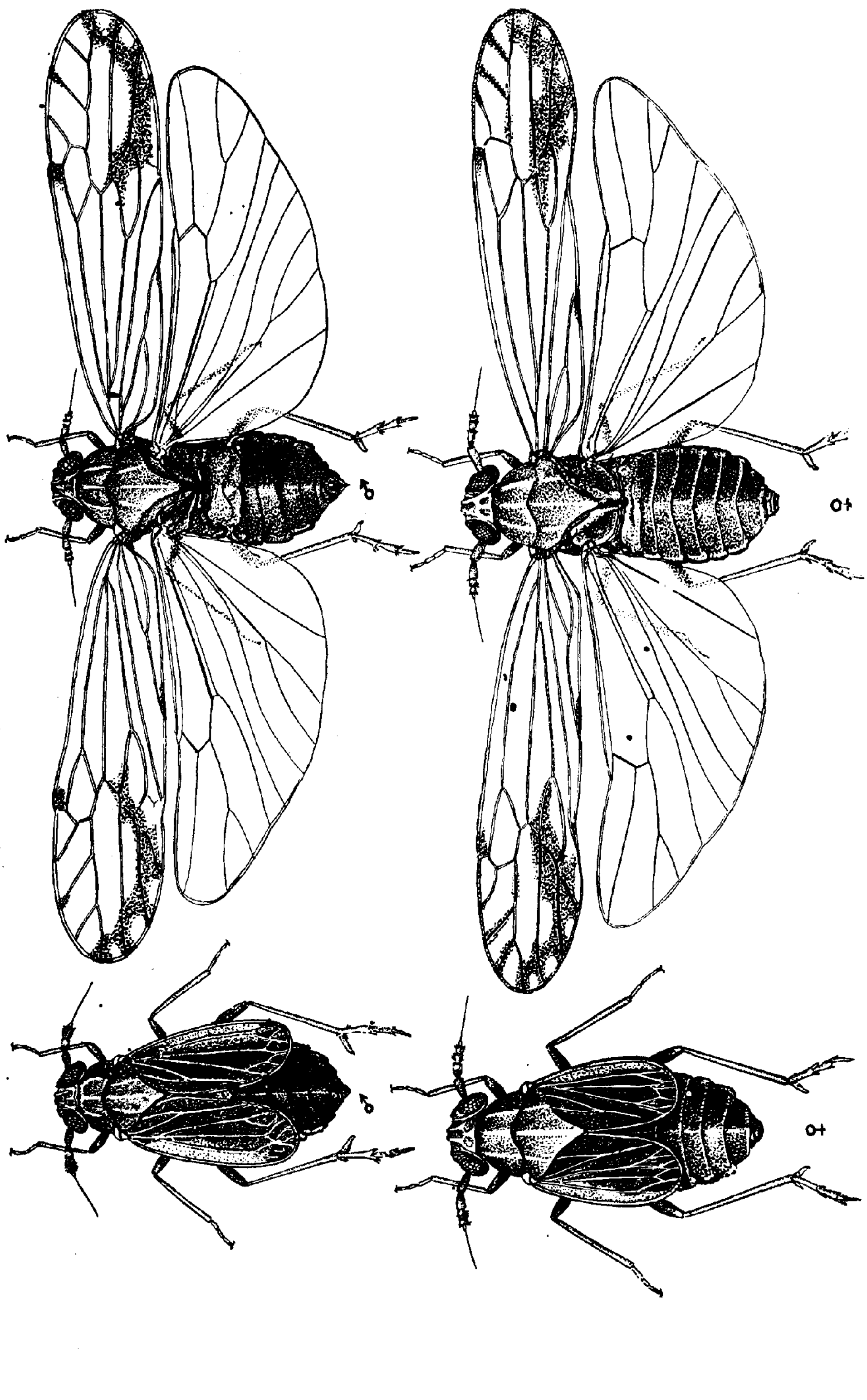
(PLATE 37.)

Pundaluoya simplicia, Dist., is a small Fulgorid attacking *Sorghum* and Maize mainly, and the spiked millet (*Pennisetum typhoideum*) to a less degree. The eggs are laid in rows inside the tissues of the midrib of leaves and also, but less frequently, in the ensheathing leaf-bases. The young ones, which are tiny and pale milky-white, are found in numbers inside the top whorls in the young plants. They are also noticeable on the *Sorghum* earheads among the developing grains. Where these bugs are abundant, the interior of the topshoots becomes filled with their sweet excretions, and rotting is set up. The nymphs pass through five moults and assume the adult stage in about 16 to 20 days. A note on the details of the life-history of this bug has been sent up for publication in the *Madras Departmental Year-Book.*

The Micropterous Form. While working at the life-history of this bug in 1914-1915, the writer noticed in two cases that adult males with half-developed wings were reared out from eggs laid by full winged females. A subsequent examination of infested plants revealed the fact that such micropterous individuals were fairly common in the field and that they were usually mistaken for nymphs of the fifth instar. Though the fact that this form occurred always in company with the full-winged one was suggestive of their being con-specific, yet there was not enough evidence to prove that they were not two distinct species. Breeding experiments were therefore undertaken to gather accurate *data* on this point.

In 1921, full-winged forms were kept separately in cages and eggs were laid in young plants and the young nymphs hatching out were introduced on pot-grown *Sorghum* plant in cages. In the same way, young bugs hatching from eggs laid by half-winged forms were also placed on another set of pot-grown *Sorghum* plants. These experiments proved, however, abortive, as the plants dried up for want of care during the absence of the writer elsewhere on official duty. In one cage, however, in which nymphs, hatched from eggs laid by full-winged females, had been let in on the 6th November 1921, five specimens of half-winged

* NOTE.—Comparison of Indian material of *P. simplicia*, Dist., with Hawaiian examples of *D. maidis*, Ashm., by Messrs. Crawford and Muir shows that the two forms are identical, and Distant's name will therefore sink as a synonym of *maidis*, Ashm.—*Editor.*



Pern dalaloua simplicia ; **on left, brachypterous male and female ; on right, fully winged male and female ; all magnified 20 diameters.**

adults (male and female) were noted in addition to nymphs on the 4th December 1921.

In 1922, the experiments were repeated, but a different method was adopted. Young *Sorghum* was grown in pots under a large cage (Cage No. I) and several full-winged male and female bugs were let in on the 11th October 1922. Towards the end of October, large numbers of nymphs were noted. On the 11th November 1922, numerous specimens of the half-winged form were noted on the leaves, but none of the full-winged form. Examination on the 16th November revealed the presence also of numerous full-winged forms.

Cage No. II. Similarly numerous specimens of half-winged adults, male and female, were placed on *Sorghum* in Cage II on the 18th October 1922. Examined on the 11th November 1922, only a small number of half-grown nymphs were noticeable. Re-examined on the 24th December 1922, most of the *Sorghum* plants were found dried up, but two full-winged forms were noted inside the cage.

Cage No. III. Several pairs of half-winged forms collected from Cage I were placed into young *Sorghum* in Cage III on 13th November 1922. Examined on the 24th December, 4 or 5 full-winged adults were noted inside the cage (in spite of the fact that the *Sorghum* plants had almost dried up inside).

These experiments prove conclusively that the dimorphism seen in this bug is intra-specific. The exact cause of the production of the half-winged form is not known, but is perhaps an index of the abundance of food material. In November several cases of the micropterous male and macropterous female, and *vice versâ*, in copulation were secured (for which I am indebted to Assistant Mr. C. J. George, Coimbatore) and this settles the question of their conspecificity once for all.

The micropterous form.

Description. Body and legs piceous, lateral margins of abdomen faintly spotted with yellow. Femora piceous, tibiæ and tarsi pale ochraceous, face with the lateral margins and bifurcating central ridge pale castaneous anteriorly, clypeus dark castaneous, antennæ piceous, with the second joint pale castaneous distally, eyes piceous, vertex pale testaceous with the carinae paler. Pronotum and mesonotum tricarinate and testaceous dorsally, the carinæ being pale grey. The sides castaneous. Abdomen shaded with piceous. Tegmina short, reaching to about middle of abdomen in females and slightly longer in males, hyaline with a yellowish tint with a large black patch apically and a small black spot on the inner margin about a third of the distance from the apex. Wings vestigial.

Votes of thanks were accorded to the Joint Secretaries of the Meeting, and to the Pusa Estate Staff for their work in connection with the arrangements for the Conference. The Meeting closed with a hearty vote of thanks to the Chairman, the Imperial Entomologist.

APPENDIX.

List of Resolutions passed by the Fifth Entomological Meeting.

Resolution I (*page* 63).

"The Conference of Entomologists at Pusa, having considered the suggestion made in Dr. W. D. Hunter's communication, of determining "by certificate or warehouse receipts that the cotton was more than six months old," and having concluded that this will not afford adequate protection against the danger of introducing the Cotton Boll Weevil, is of opinion that the Indian Central Cotton Committee should consider the advisability of recommending the total prohibition of cotton from America; and as an alternative, that all bales containing such cotton should be fumigated at port of entry, and that entry should be restricted to Bombay."

Proposed by Mr. P. B. Richards,

Seconded by Mr. G. R. Hilson,

and passed unanimously.

Resolution II (*page* 399).

"This Meeting recommends to the Indian Universities that the subject of Entomology be taught as of equal rank with other branches of Biological Science in the courses of study for the examinations of the Universities for degrees in Science including Agriculture."

Proposed by Dr. K. Kunhi Kannan,

Seconded by Mr. M. Afzal Husain,

and carried by majority.

Resolution III (*page* 402).

"That in view of the great value of these Conferences to Entomological workers in India and elsewhere, this Meeting is of opinion that the biennial Entomological Conferences should be continued in order to afford facilities to workers in all fields of Entomological research to meet and discuss the work in their respective fields."

Proposed by Dr. K. Kunhi Kannan,

Seconded by Mr. M. O. T. Iyengar,

and passed unanimously.

INDEX

All scientific names of insects are indexed under both specific and generic names, but page references are only given under the latter.

All names *in italics* are treated as synonyms and should be looked up in this Index under the names given in roman letters.

An asterisk against a page reference indicates that a figure of the insect referred to is given on a plate opposite the page cited.

For titles of Papers see pp. ix—xi.

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